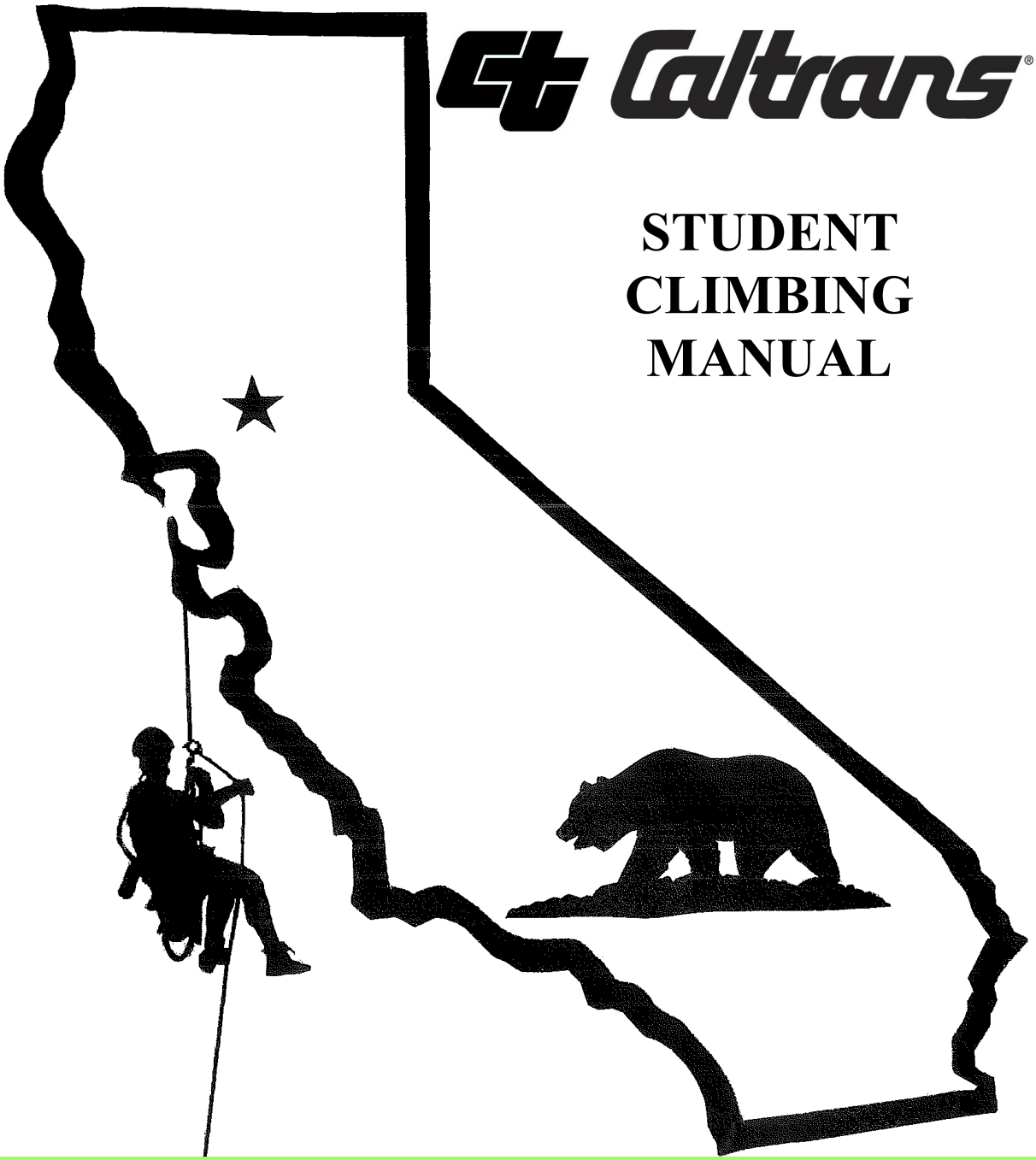
CALTRANS
BANK SCALING & ROCK CLIMBING
V9.0



STUDENT CLIMBING MANUAL


IN MEMORY
OF OUR
FALLEN FRIENDS
IN
CLIMBING

Caltrans Bank Scaling and Rock Climbing Training

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Chapter 1

Introduction

This handbook is designed as a companion to the Caltrans Bank Scaling and Rock Climbing Training Course. Its purpose is to help climbers understand what is involved in bank scaling operations, as well as the gear and equipment necessary to do the work.

Throughout this handbook, reference is made to "climbers." A climber is any personnel assigned to perform rope work. Bank scalers, when required to work on rope, are climbers. Lookouts, when required to work on rope, are climbers. No matter what your classification is, if you are working on rope for Caltrans, you are considered a climber. All Caltrans climbers are volunteers.

Experienced climbers are a valued asset for the Department. Many agencies require that climbers have a minimum number of hours on rope, or years of experience, to work as a bank scaler. Keeping a personal climbing log helps to document your experience. As such, it is important to keep track of the number of hours you spend working on rope. In the Appendix of this manual, there is a Personal Climbing Log form to help keep track of your climbing hours.

It is important to always keep safety in mind as you work on rope. Safety starts with preparation. Just approaching a slope where there are unstable rocks means you have to be aware of your surroundings and the dangers they might pose. Considering this, a climber should be aware of the conditions and environment where they will be climbing. Also included in this manual is a Scaling Slope Assessment form. Each climber in a scaling operation needs to be familiar with the Assessment for the specific site they will be scaling. This will help to prepare you for your climb.

Classroom Topics

- **Introductions**
  - **Name**
  - **Department**
  - **Climbing experience**
- **Classroom**
  - **Location of nearby Hospital or medical facility**
  - **The safe approach to climbing and the different applications.**
  - **Code of Safe Operating Practices.**
  - **Cal-OSHA safety regulations.**
  - **Specifications for rockfall mitigation.**
  - **Personal Climbing Log**
  - **Climbing gear.**
  - **Rope safety.**
  - **Knots for rope, webbing, and accessory line.**
  - **Site evaluation.**
  - **Anchor systems and backups.**
  - **Wrap up.**
- **Field exercises.**
  - **Locations and access.**
  - **Anchor systems.**
  - **Buddy system.**
  - **Belay station.**
  - **Terminology.**
  - **Check off list.**
  - **Potential Hazards.**
  - **Emergencies.**
  - **Travelling to sites.**

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Application of mountaineering techniques to rock cut slope analysis and rockfall mitigation

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ABSTRACT: Rockfall has been reported along nearly 3000 miles of California highways. As transportation corridors become more restrictive, stabilization of existing rock cuts become critical. Typically, these sites are in areas where access is limited to examination from road level. Application of mountaineering techniques to aid the engineering geologist in conducting a close-up examination of rock slopes is discussed. Guided by radio with an experienced ground crew using oblique aerial photos from road level, the Engineering Geologist on ropes can collect critical data on the slope. Planar features controlling stability can be examined and measured directly. Changes in discontinuity spacing, presence of water, or attitude can be measured directly. Critical control points on the slope can be accurately located by a survey crew at road level shooting a target held by the mountaineering crew. The application of rock mechanics to cut slope design and rockfall mitigation through safe, controlled climbing techniques is emphasized.

1. INTRODUCTION

In California there are thousands of miles of highway that are cut through rock. As highway usage increases, these highway corridors are constantly undergoing improvements. Current trends in land usage frequently limit transportation corridors. As these corridors become more confined, stable new slopes and stabilizing old problem slopes becomes increasingly critical.

In the past, cut slopes were constructed without analysis of the rock characteristics which resulted in problem areas. Today high rock cut slopes are being designed based on rock characteristics using rock mechanic techniques. The parameters used in these designs are typically obtained from investigations conducted at road level and the surrounding slopes. Rock design has, therefore, been limited by the Engineering Geologists lack of access to the actual rock cut slope face.

Mountaineering techniques involving climbing ropes allows the Engineering Geologist (EG) to move freely on the slope and conduct a hands-on investigation of rock faces. This paper outlines mountaineering procedures used by the California Department of Transportation (Caltrans) to investigate rock cut slopes and presents case histories where mountaineering techniques were used in rock cut investigations.

2. MOUNTAINEERING

Mountaineering often conjures images of treacherous climbs up Half Dome, expensive equipment, superior physical condition, and years of training. Climbs of that magnitude do require such preparation. Climbing rock cut slopes, however, is much less intense and can be performed by anyone in good physical condition.

Understanding the techniques and equipment is important. Instruction regarding both the use of the equipment and techniques is essential for safe climbing. Instruction is available from outdoor organizations such as the Sierra Club and climbing groups. Classes can be designed for all levels of skill and experience. The classes are inexpensive and provide students with the opportunity to see if they are suited to this activity.

2.1 Equipment

Mountaineering equipment costs are low, especially compared to potentially high costs incurred by improper rock design. Quality equipment can be purchased for a few hundred dollars from specialty sporting goods stores.

The following is a general list of mountaineering equipment used by Caltrans EGs for rock slope investigations:

- Mountaineering rope; A synthetic fiber, 7/16' in diameter, that is lightweight, strong, and manageable.
- Seat harness; Provides safety and comfort while the climber hangs from the rope.
- Nylon webbing; Made into loops called runners, the purpose of which is to connect the climber to points of security such as rock knobs and/or anchors placed by the climber.
- Carabiners; Metal devices similar to large safety pins, used to connect various elements of the climbing gear, such as rope and piton.
- Anchors; Common types are pitons, chockstones and wired stoppers. These are pieces of metal of various shapes placed or driven into cracks in the rock for protection.
- Rescue-8 ring; A metal device shaped like an 8, which provides friction for control during the belay.
- Ascenders; Mechanical devices used for climbing, descending, securing, and load hauling.
- Etriers; A short rope ladder used in pairs in conjunction with ascenders for ascending steep and difficult rock faces.

This equipment is available from a variety of manufacturers. Our current inventory is sufficient to meet the needs of rock cut slope investigation. While most of the equipment will last for many years with proper care, ropes and webbing become frayed and weakened and, therefore, require periodic inspection and replacement.

2.2 Ground support

A major factor in the success of this type of investigation is the support crew. Most crews consist of two EGs, one assistant, and when necessary, traffic control crews. At least two people on the job should have training in mountaineering (preferably the two EGs on the job). This is a safety consideration. The alternate climber can help in the event of an accident and can relieve the other climber when he is tired. If possible, a team of EGs should be estab- lished that works together consistently, thereby promoting efficiency and safety. In Caltrans, Engineering Geology Section, three EGs have been trained together and work together. In most cases, two of the three are available for projects requiring rope work.

Before the investigation begins, oblique photographs of the entire site should be obtained. Most sites are photographed from the surrounding slopes; in cases where terrain and/or access presents a problem, photographs are taken from a helicopter. Eight by 10-inch photos are the most ideal size to work with. Larger prints were found to be cumbersome. The photos are used to aid the EGs in locating target spots, to direct the climbing EG to key locations, and for mapping, which is done directly on the photos during the investigation.

Communication between the entire crew is essential. We have found that manual or voice- activated radios provide the easiest and safest form of communication. Both are satisfactory; however, the voice-activated radio is the most convenient. When a rock is intentionally or accidentally dislodged by the climbing EG, hand signaling and shouting cannot compare to the advantages of immediate radio contact with everyone in the support crew. Radio communication also makes it easier for the support EG to direct the climbing EG and to relay data.

When available, a survey party is on-site to accurately record specific locations and slope geometry as designated by the EG.

2.3 Technique

When all the preliminary preparations are completed, the climbing can proceed. The mountaineering rope is secured at a stable location at the top of the cut and the geologic investigation is conducted as the EG rappels down the slope. Data are collected and transmitted via radio to the support EG at road level. The support EG uses the photos and his road-level perspective to direct the climbing EG as he works on the slope. Target areas can be identified, examined, mapped, and recorded. As the investigation progresses, additional data, identified by the climbing EG not noticeable from road level, are relayed to the support EG who records and maps the data on the photos.

On the slope, the EG's mobility is essentially unrestricted. The rescue-8 ring and one ascender are used during the rappel. A second ascender allows an easy ascent if necessary. Difficult

ascents, such as vertical cuts and overhangs, are relatively easily performed by attaching etriers (rope ladders) to the ascenders.

Stopping to work is easily achieved by one quick movement with the ascender. At this time, both hands are free to measure the attitudes of controlling planar features or do other work. Moving at an angle to the right or left is facilitated by placing anchored protection into the rock. This anchorage prevents the rope from sliding across the rock, and dislodging rocks above the climbing EG, and it prevents the climbing EG from swinging across the rock face if he should slip.

After one section of the slope has been adequately examined, the rope is moved to a new station, and the investigation proceeds.

These mountaineering techniques permit the EG to move with relative ease up, down, and across the entire rock slope. In this fashion, a detailed geologic investigation can be conducted on the slope above the roadway in a relatively short amount of time. The results of this type of investigation using mountaineering techniques have been successful and well received. Such detailed investigations have yielded information necessary for recommendations regarding the most appropriate and economical design for improving rock cut slopes.

3. CASE HISTORIES

The following case histories illustrate the advantages of working on the slope and compare the results to those obtained from road level.

3.1 Panorama Point

The site is located within the eastern portion of the San Bernardino mountains. The rock type at the site is Quartz Monzonite, late Cretaceous in age. This rock unit is referred to as the "Cactus Granite". The cut slope is approximately 1/2:1, 200 feet in width, and 125 feet
high. Caltrans maintenance workers noticed that rockfall had increased in recent months from a few rocks per month to a few rocks per week. Several rocks as large as 11 feet by
2.4 feet fell within two weeks of each other. In the vicinity of these occurrences, several cracks appeared to be widening behind rock adjacent to the roadway.

A detailed investigation was conducted in October 1986. The investigation included mapping the extent of the cracking, measuring strikes and dips of the discontinuities, and locating water seepages. In addition to this, a number of precariously placed rocks were pushed off the slope and their rock trajectories observed.

Results from the mountaineering investigation

Detailed mapping done on the slope face revealed a pattern of small wedge failures occurring above the overhanging rock. It was discovered that the failures were associated with a particular discontinuity. Fractures observed at road level were found to extend upslope and were critical to the design. It was also determined that controlled blasting in a limited area would mitigate the unstable section. In addition, certain areas were to be reinforced with rock bolts. This design would not affect the nearby homes.

3.2 Kern Canyon

The project is located at the base of the Kern River Canyon. The canyon is approximately 1700 feet deep at this site. The upper slopes of the canyon are I 1/4: I while the inner gorge of the canyon can be 1:1 or steeper.

Bedrock at this site is gray fractured qabbro-diorite, Jurassic in age. The rock is locally intruded by numerous white pegmatite dikes.

The existing cut slope is approximately 200 feet in length, 90 feet high, and ragged. The slope angle is nearly vertical.

Local Caltrans highway engineers plan to make a safety improvement at this location by improving the radius of curvature. They requested that a cut slope investigation be done to determine the steepest stable cuts that can be constructed.

A detailed investigation was conducted in December 1987. This investigation consisted of measuring discontinuity attitudes, mapping, classifying the discontinuities, and locating water seepages.

Results from the road level investigation

Data collected from road level indicated that a 1/2: I slope would be stable. For this design, approximately 11,000 cubic yards of material would be excavated. A second option was to construct a 1/4: 1 slope, reinforced with rock bolts. This design would reduce excavation volumes by 50 percent. The rock bolt design consists of 100 sixteen-foot rock bolts spaced eight feet apart.

Results from the mountaineering investigation

This part of the investigation also concluded that a 112: I slope or a reinforced 1/4: 1 slope would be stable. However, specific data collected on the slope revealed that the discontinuity spacing was regular enough to map three distinct discontinuity groups and that each group warranted its own bolt design. The first group, having closely spaced discontinuities, required 33 twelve foot bolts spaced 6 feet apart. The second group, with moderately spaced discontinuities, required 16 twenty-foot bolts 12 feet apart. The third group was so large that

no reinforcement was required. The resulting overall design reduced the amount of reinforcement necessary for stability by 40 percent, resulting in significant savings.

3.3 McDonalds Bluff

The site is located along the upper slopes of the Trinity River Canyon. The canyon is approximately 1200 feet deep at this site. Natural slopes of the canyon are
1 1/4:1 or flatter but become steeper below the roadway.
Bedrock is highly fractured meta-sedimentary rock, pre-Cretaceous in age. The rock 1s intruded locally by diabase dikes.

The cut is approximately 980 feet long and 480 feet high. The existing cut stands on an overall 1 1/9:1 slope but is quite variable with some sections being near vertical.

An investigation was requested by local Caltrans maintenance personnel because of the frequency of rockfall. In addition to rockfall, the site also experiences occasional debris slides and rockslides large enough to close the roadway. An investigation was conducted in August 1988.

Results from the road level investigation

Very little specific data could be collected from road level that pertained to the instabilities. Visibility was limited from road level and adjacent slopes. Stereographic analysis of data collected at road level indicated that a 1 112:1 slope would be stable. However, this analysis was based on the premise that the discontinuity orientations were similar 500 feet upslope.
In highly fractured rock this assumption requires confirmation. If such a slope were constructed, it would generate approximately 700,000 cubic yards of material. Other mitigation measures considered were construction of a viaduct, redirecting the road away from the cut, installation of a rock shed over the roadway, or installation of a catchment wall at grade.

Results from the mountaineering investigation

On the slope, instabilities unseen from road level were mapped and identified. At this time, discontinuity orientations were measured for stereographic analysis, and slope profiles were measured for rock trajectory analysis. Other information collected at this time included locating sources of potential rockslides and debris avalanches. The investigation also yielded information useful in evaluating the feasibility of localized mitigation measures such as rock nets, draped wire mesh, scaling, and trimming.

This investigation yielded information that ruled out localized mitigation measures such as rock nets, draped wire mesh, scaling, and trimming. The mountaineering work developed information on rock sizes and trajectories that will help in the design of the more comprehensive measures.

4. CONCLUSION

The accuracy and precision of data determine the accuracy of the design. Mountaineering techniques used in rock slope investigations provide data otherwise not available for rock cut design. As exemplified in the case histories, information collected on the slope can provide data that improves design or provides additional information that supports recommendations made from road level observations. In either case, the use of mountaineering techniques for rock slope analysis improves the quality of the data the Engineering Geologist needs to analyze rock cut slopes.

Circa 1987
Tim Beck and John Duffy

Scaling- Not Just a Random Act of Engineering

By definition scaling is the removal of marginally stable or unstable rocks from the face of a rock slope. Caltrans geologists direct scaling operations to protect people and facilities from falling rocks. Maybe it's not so simple after all. Well, in fact, it isn't.

When is scaling appropriate? How is it done and by whom? Scaling is not "a random act of engineering" but is an organized, deliberate discipline founded on geologic and engineering principles and is a technique used throughout the world.

First and foremost is when to scale? Many older slopes throughout California are aging. In each instance, the aging process, often accelerated by winter storms and earthquakes, eventually weakens the surface of the slopes resulting in loose blocks of rock on the slope face. In time, just as with structures, the slope surfaces need maintenance. While a variety of maintenance options and repair designs are available to mitigate rockfalls, rock patrols and rock scaling are typically the first line of defense. With over 3000 miles of roadway in California having slopes with rockfall potential maintaining them is a challenging endeavor.

Every slope is different and is distinguished by its size, character, and properties. Assessing these characteristics falls into the responsibility of engineering geologists and maintenance personnel.

Engineering Geologists and Maintenance Evaluating a Slope

Maintenance forces know the slopes in their areas and understand each slopes behavior such as rockfall frequency, rockfall sizes, and when the rocks are falling. This information is invaluable to engineering geologists who study the rock properties, structure, and slope geometry as they relate to rockfall behavior. Together, rockfall characteristics are evaluated and the decision when to scale or not to scale is determined by answering the questions; is it to dangerous to scale? will the scaling operations cause more problems? or is it worth scaling?

Caltrans Bank Scaling and Rock Climbing Training

1930's Climbing Techniques

Following World War II with the introduction of mountaineering techniques from Europe, climbers started looking towards much safer techniques for accessing the slopes. At first this technology, although sturdy, was heavy and limited movement on the slope. Today many improvements have been made for industrial climbing, recreational climbing and rescue climbing. But nothing in particular was developed for people working on rock cut slopes with loose rocks. It's no wonder because most people do not want to venture there.

Faced with this void Caltrans Engineering Geologists, in the mid 1980's, working with maintenance began developing a structured program for scaling slopes. Initially recreational climbing tools were used to access the slopes for reconnaissance, mapping, and design purposes. While on the slopes loose rocks were removed as part of the investigation and quickly it was realized that these climbing techniques enhanced mobility and safety on the slope and suited more comprehensive scaling operations.

Preparing for a Scaling Operation

Engineering geologists, in the early 1990's, workings closely with Caltrans rock and avalanche blasters began developing a class to train workers in scaling and teach the skills needed to access the slopes with ropes. First a maintenance code of safe operating practices was developed entitled "Bank Scaling and Rock Climbing." In conjunction with this an 8-hour class was developed and taught at the old META facility at Camp San Luis Obispo. Since those early classes many changes have occurred and today the class is 16-hours and taught at the Kingvale Maintenance Academy. A manual and supporting video have been developed and there are over 20 volunteer trained instructors.

Kingvale Maintenance Facility

Scaling teams and other trained personnel currently exist in all Districts. In addition to slope maintenance activities other disciplines are benefiting from this training including construction, surveys, geotechnical, hydraulics, storm water teams, and environmental.

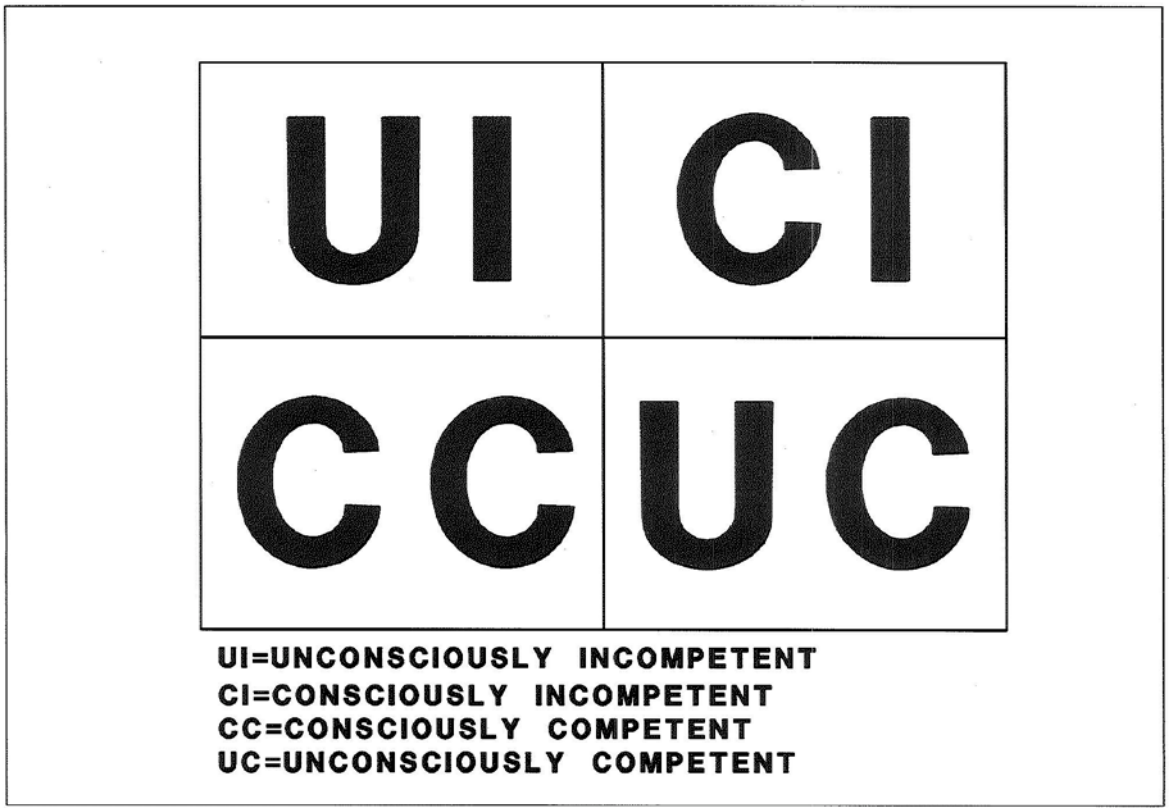
Caltrans Bank Scaling and Rock Climbing Training

Rock Scaling

Caltrans scaling training program is the only one of its kind and Caltrans regularly receives inquires from across the US and abroad. Caltrans scaling teams have been featured in the National Geographic special "Landslides" and the Learning Channel Special "Disaster Detectives." It is truly a unique program enabling Caltrans to employ best management practices. Climb on!

Chapter 2

Safety Procedures



Drawings presented with permission from the Professional Climbing Instructors Association

BANK SCALING AND ROCK-CLIMBING PREPARATIONS

Before starting a scaling operation, take all precautions to protect the property, the traveling public and employees from injury or accidents.

1. Park where you can safely enter and exit the vehicle without creating a hazard for yourself or others.
2. Review the protection procedures and traffic control requirements for the work area.
3. Discuss specific site conditions and the SCALING ASSESSMENT FORM.
4. Discuss work procedures and assignments during pre-job briefing.
5. Discuss the General Safety Conditions outlined in the SCALING OPERATIONS - SITE RECON MEETING CHECKLIST.
6. Locate all utilities before starting operation.

A **qualified person** is a person who because of experience or instruction is familiar with the operation to be performed and the hazards involved.

A qualified Caltrans person directs the operation and has the authority to relieve any person for non-compliance of these orders.

Refer to the Caltrans Maintenance Manual, Volume 1, 2006, Chapter X - Scaling; and the Caltrans Safety Manual, Chapter 21 - Cut Slope Safety.

LOOKOUTS

Use lookouts to watch the face of the slope and to give warning when loose rock or other material starts to fall.

Place lookouts carefully to reduce their exposure to falling material, operating equipment and moving traffic. The number and placement of lookouts is at the discretion of the qualified person who is directing the operation.

- **Lookouts shall have completed the Caltrans Slope Scaling Assessment class and be competent in basic rockfall science and hand scaling procedures. They have the authority to clear the area or stop work at any time.**
- **Lookouts at the top of the slope shall attach a safety line and properly tie in.**
- **Lookouts review and change pre-planned escape routes as necessary.**
- **Lookouts have the authority to clear the area or stop work at any time.**
- **Rotate lookouts periodically to avoid lowered levels of alertness.**

Communication

Lookouts shall have adequate communications with climbers and equipment operators at all times.

If voice communications are used, an alternate alarm system shall be provided. (hand held air horn, etc.)

Should communications not work properly, the lookout shall stop the operations until the situation is corrected.

ROPE WORK

Personnel assigned to perform rope work shall be trained and outfitted with approved climbing gear in accordance with the safety commission, Union International des Association (U.I.A.A.). All safety belts, harnesses, lanyards, climbing ropes, lifelines, drop lines and carabiners shall meet or exceed ANSI A10.14-1975 standards.

- All rope work shall be performed on a voluntary basis.
- Review safe practice rules for equipment and pre-op equipment
- Use required personal protective equipment.
- All climbing gear shall be inspected daily, both prior and after use.
- Ropes used for bank scaling shall be a kernmantle static type approved rope for mountaineering.
- Ropes shall have 5400 pounds minimum tensile strength.
- A climber shall maintain two points of contact to the climbing rope during all climbing operations.
- All climbing ropes should have at a minimum a figure eight knot tied to in the end of the climbing rope.
- Rope ends shall be either braided or melted to prevent unraveling.
- Do not use climbing ropes for any purpose except climbing operations.
- Only approved mountaineering knots shall be used.
- Do not splice climbing ropes. Use only approved bends to connect ropes.
- Ropes made unsafe by damage or by any other reason shall be marked and not be used for climbing.
- Store ropes used for climbing away from cutting edges, sharp tools, corrosives, chemicals, or gas.
- Carabiner - All carabiners under impact loads shall withstand a minimum 5000-pound tensile test without fail. Refer to ANSI A10.14-1975.
- Carabiners shall never be oiled.
- Locking carabiners, or two opposite and opposed non-locking carabiners, shall be used at all connections between the climber and the anchor.

CLIMBING ON ROCKFALL PROTECTION SYSTEMS

(This page is under development)

CODE OF SAFE OPERATING PRACTICES

ROCK SCALING

Personnel assigned to scale slopes shall be trained and outfitted with approved climbing gear in accordance with the safety commission, Union International des Association (U.I.A.A.). All safety belts, harnesses, lanyards, climbing ropes, lifelines, drop lines and carabiners shall meet or exceed ANSI A10.14-1975 standards.

HAZARD REVIEW

WORK AT HEIGHTS AND ON UNEVEN GROUND
OVERHEAD FALLING/SLIDING MATERIAL
ROCK AND DEBRIS ON THE ROADWAY
MOVING EQUIPMENT
MOVING TRAFFIC
WORKERS ON FOOT
SLIPPING AND TRIPPING HAZARDS
POOR VISIBILITY

SAFE OPERATING PROCEDURES

1. Before work is started a competent[1] person must evaluate what hazards are apparent and the scope of the work involved. This evaluation should include an examination of the area and adjacent areas for ground cracks and excessive water flows as well as loose boulders, trees and other debris on slopes. The evaluation shall include completion of a written Slope Scaling Assessment Form as described in Chapter 3 (Site Evaluation) of the Caltrans Climbing Manual*. The form will then be sent to a qualified[2] person in the Geotechnical Branch for review and approval/modification. Slopes will receive a classification from 1 to 5.
2. A competent Caltrans person will direct the operation, and have the authority to relieve any person for noncompliance to procedures or direction.
3. Classification 3-5 slopes require that a competent Geotechnical Services person be on site watching the slope during scaling operations. This is in addition to the competent person directing/managing the operation.
4. Pre-op equipment and review safe practice rules for applicable equipment.
5. Review work area protection procedures and any traffic control requirements.
6. Park in an area suitable for safe entering and exiting of vehicle and which does not cause a hazard to yourself and others.
7. While on foot make every effort to perform your work facing oncoming traffic.
8. Use required personal protective equipment.
9. Before starting any scaling operation, daily pre-job briefing, work procedures and assignments shall be discussed.
10. Location of all utilities shall be known before starting operations.
11. Before starting any scaling operation all precautions shall be taken to protect property, traveling public and employees from injury or accidents.
12. Keep work area clear and be aware of surroundings. Danger areas shall be posted with signs and barriers.
13. All climbing gear shall be inspected daily, both prior and after use as described in the Caltrans climbers manual*.

14. Before climbing operations begin there shall be on site at least one trained aerial rescue climber on standby.
15. A lookout shall be used to continually watch the face of the slope and give warning when loose rock or other material starts to fall.

    a. Lookouts shall have completed the Caltrans Slope Scaling Assessment class and be competent in basic rockfall science and hand scaling procedures. They have the authority to clear the area or stop work at any time.

    b. The number and placement of lookouts is at the discretion of the competent person who is directing the operation. Lookouts should be carefully placed to reduce their exposure to falling material, operating equipment and moving traffic.

    c. Lookouts shall have adequate communications with climbers and equipment operators at all times. When using voice communication devices with optional voice activated and push to talk modes, the lookout shall use the voice-actuated mode and equipment operators shall use the push to talk mode. If voice communications are used, an alternate alarm system shall be provided,
    e.g., hand held air horn, etc. Should communication not work properly, the lookout shall stop the operation until the situation is corrected.

    d. Lookouts shall have pre-planned escape routes which will be reviewed and changed as neces - sary.

    e. Lookouts should be changed periodically to avoid lowered levels of alertness.

    f. All lookouts at the top of the slope should have a safety line attached to themselves and be properly tied in.

*Caltrans Bank Scaling and Rock Climbing

[1] "Section 1504(a) of the Construction Safety Orders (CSO) defines a competent person as: One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them." Caltrans Safety Manual 21.04.

[2] A qualified person is a person designated by the employer; and by reason of training, experience, or instruction has demonstrated the ability to perform safely all assigned duties; &, when required is properly licensed in accordance with federal, state, or local laws and regulations.

Reprinted from Division of Maintenance Code of Safe Operating Practices - Section II

Cal-OSHA – Climbing on Slopes

Title 8, Sub Chapter 4 , Article 24 is the governing safety order.
Subchapter 4. Construction Safety Orders
Article 24. Fall Protection
http://www.dir.ca.gov/Title8/sub4.html

§1671.1. Fall Protection Plan.

(a)This section applies to all construction operations when it can be shown that the use of conventional fall protection is impractical or creates a greater hazard.

(1)The fall protection plan shall be prepared by a qualified person and developed specifically for the site where the construction work is being performed and the plan must be maintained up to date. The plan shall document the identity of the qualified person.

NOTE: The employer need only develop a single site fall protection plan for sites where the construction operations are essentially identical.

(2)Any changes to the fall protection plan shall be approved by a qualified person. The identity of the qualified person shall be documented.

(3)A copy of the fall protection plan with all approved changes shall be maintained at the job site.

(4)The implementation of the fall protection plan shall be under the supervision of a competent person. The plan shall document the identity of the competent person.

(5)The fall protection plan shall document the reasons why the use of conventional fall protection systems (guardrails, personal fall arrest systems, or safety nets) are infeasible or why their use would create a greater hazard.

(6)The fall protection plan shall include a written discussion of other measures that will be taken to reduce or eliminate the fall hazard for workers who cannot be provided with protection provided by conventional fall protection systems. For example, the employer shall discuss the extent to which scaffolds, ladders, or vehicle mounted work platforms can be used to provide a safer working surface and thereby reduce the hazard of falling.

(7)The fall protection plan shall identify each location where conventional fall protection methods cannot be used. These locations shall then be classified as controlled access zones and the employer must comply with the criteria in Section 1671.2(a).

(8)Where no other alternative measure (i.e. scaffolds, ladders, vehicle mounted work platforms, etc.) has been implemented, the employer shall implement a safety monitoring system in conformance with Section 1671.2(b).

(9)The fall protection plan must include a statement which provides the name or other method of identification for each employee (i.e., job title) who is designated to work in controlled access zones. No other employees may enter controlled access zones.

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

SAFETY MEETING REPORT

PM-S-0110 (REV. 05/2009)

Lock Data on Form

ACTION AND DISTRIBUTION:

- ☐ 1. First-line supervisor conducts meeting, completes, and sign form.
- ☐ 2. First-line supervisor retains and posts one copy.
- ☐ 3. First-line supervisor sends original to second-line supervisor for review.
- ☐ 4. Second-line supervisor reviews, signs original, and returns to first-line supervisor to file.
- ☐ 5. Additional routing to:

Note: See Chapter 2, Safety Meetings, in the Caltrans Safety Manual for details.

DATE	OFFICE / CREW / PROJECT NAME	COST CENTER / PROJECT NUMBER

PRINT NAME OF EMPLOYEES (Add additional sheets if required)

SAFETY TOPICS DISCUSSED

SAFETY SUGGESTIONS/COMMENTS

SUPERVISOR'S COMMENTS

FIRST-LINE SUPERVISOR SIGNATURE	DATE	SECOND-LINE SUPERVISOR SIGNATURE	DATE

SUGGESTED TOPICS FOR DISCUSSION

☐ Safe work habits	☐ Maintenance, Chapter 8	☐ Respirator safety	☐ Safety vest
☐ Safe work conditions	☐ Traffic control/flagging	☐ Confined spaces	☐ Body protection
☐ Codes of Safe Operating/Work Practice	☐ Slip/trip/fall hazards	☐ Hard hats	☐ Foot protection
☐ First aid treatment	☐ Protective vehicles	☐ Safety glasses	

ADA Notice For individuals with sensory disabilities, this document is available in alternate formats. For information call (916) 654-6410 or TDD (916) 654-3880 or write Records and Forms Management, 1120 N Street, MS-89, Sacramento, CA 95814.

SUMMARY

- **Preparation is key to safety**
- **Lookouts must be able to see the entire work area, and give warning when necessary**
- **Working on Rope requires specialized equipment and the training to use the equipment**
- **Follow Code of safe operating practices- Rock Scaling**
- **BE SAFE!**

REMEMBER!

ALWAYS USE TRAFFIC CONTROL WHEN WORKING ON SLOPES ABOVE THE HIGHWAY

Chapter 3

Site Evaluation

SITE EVALUATION PREPARATION

- **Approach the site with caution.**
- **Analyze the access and departure very carefully.**
- **Always have backup plan of exit.**
- **Never enter a situation that you are unsure of getting out of.**
- **Never descend into a depth that you are not prepared to climb up your rope to get out.**
- **Take note of hazards on the way down and keep an eye on them when they are above you.**
- **Always tell someone when you are going to climb.**

•Never climb alone.

ROPE CONTACT DURING SCALING

- 90 % of the time the slope conditions are such that the rope does not even touch the ground or contact is very limited and edge guards can be easily used to protect the rope.
- In more difficult conditions where there might be frequent rope contact with the ground or conditions are very loose and random rockfalls are possible, climbing on belay should be considered. This consists of the climber being on two ropes. The second rope is either a belay from a partner above the slope or the climber is rappelling with two ropes.
- Finally, some slopes are too unstable to scale and should be avoided.

ROPE CONTACT DURING SCALING

1) AVOID
2) MITIGATE ┐— **90%**
3) BELAYED
- **ASSISTED BELAY**
- **TWO ROPES**

4) DON'T SCALE OR CLIMB

SITE EVALUATION

An assessment of slope conditions must be performed before any scaling work begins. A qualified/ competent person shall complete a Slope Scaling Assessment form when first considering the location for scaling. A blank form is included in this chapter. The form will then be sent to a qualified person in the Geotechnical Branch.

The evaluation should include:

- Slope characteristics
- Conditions above the slope
- Roadway characteristics
- Previous rockfall and scaling activity
- Diagram of slope and areas to be scaled
- Photos
- The final Geotech classification

The result of the slope assessment will fall under one of five classifications. The classifications are summarized in the Scaling Classification System on the following page.

The slope conditions represented by a completed Slope Scaling Assessment form are valid for a maximum 90 days from the date of the assessment. Scaling operations must commence within the 90 day time period. Beyond 90 days, the slope shall be reassessed and a new Slope Assessment Form completed. Within the 90 days, should the slope conditions change due to an extraordinary event, such as freeze-thaw, storm activity, earthquakes, etc., the slope shall be reassessed and a new Slope Assessment Form completed.

A copy of the form shall be provided to each scaler, spotter, and ground control person at the site. Each scaler should keep a copy of the form for each scaling operation they have taken part in.

A qualified person must have successfully completed:

- The Beginner (Level 1) class
- The Refresher (Level 2) class
- The slope assessment training class
- And participated in a minimum of 6 hand rock scaling operations.

SCALING CLASSIFICATION SYSTEM

Class 1

- Beginner training required.
- Low slope lengths (<100') and shallow angles (<45 degrees).
- Anchor locations have easy access (slopes <20 degrees) and good abundant dependable anchors (large trees etc).
- Slope face is moderately eroded and light scaling is required.
- There are no key blocks, overhangs, chutes or presence of water.
- Light physical conditioning required.
- Basic anchor building skills required.
- Competent person to be on site watching the slope during scaling operations.

Class 2

- Beginner training required.
- Moderate slope lengths (<200') and slope angles between 45 and 70 degrees.
- Anchor locations have moderate access (<45 degrees) and good dependable anchors (large trees, rock out-crops, etc).
- Slope face is moderately to highly eroded and light to moderate scaling is required.
- There are no key blocks, overhangs, chutes or presence of water.
- Moderate physical conditioning required.
- Basic anchor building skills required.
- Competent person to be on site watching the slope during scaling operations.

Class 3

- Refresher training required.
- Moderate to high slope lengths (200' to 400') and slope angles between 45 and 70 degrees.
- Limited anchor locations (occasional trees, shrubs, rock out crops).
- Slope face is highly eroded and moderate to difficult scaling conditions.
- There are no key blocks; some overhangs, limited chutes or some water present.
- Good physical conditioning required.
- Good anchor building skills required.
- Competent Geotechnical person to be on site watching the slope during scaling operations.

Class 4

- Refresher training required.
- High slope lengths (>400') and slope angles (>70 degrees)
- Scarce to difficult anchor locations (occasional trees, shrubs, rock out crops).
- Slope face is extremely eroded and with difficult scaling conditions.
- There are no key blocks; numerous chutes and prominent overhangs.
- Excellent physical conditioning required.
- Excellent anchor building skills required.
- Competent Geotechnical person to be on site watching the slope during scaling operations.

Class 5

- No hand scaling on ropes unless a thorough geotechnical review is performed.

Slope Scaling Assessment **Version 4.1**

Dist. _____Co. _____ Rte._____PM _____ Dir:____ ADT:_____

Slope Name: _____ Classification of Slope: _____

Preparer:_____ Reviewed By: _____ Date:_____(valid for 90 days max)

This form is to be prepared by a trained, qualified person and sent to Geotechnical Services for review by qualified personnel.

Previously Classified: no yes if yes, **Date:_____ Prev. Classification : _____**

PART 1 : GENERAL SITE INFORMATION

Slope Description

Cut Slope Natural Slope Recent/Old Slide (requires 2nd level review, contact Geotechnical unit in your area for additional review)

Slope Length (sketch in cross section in Part 2)

<100' <200' <400' >400' (significant exposure time)

Slope Angle (sketch in cross section in Part 2)

35° to 45° >45° to 70° >70° to 90° Overhanging

Slope Width (sketch in front view) W =_____(W/20 = # of Scalers) # of Scalers_____

Catchment Ditch Effectiveness (sketch in cross section in Part 2)

Good Catchment Moderate Catchment Limited Catchment No Catchment

Anchor Conditions above Slope (sketch in cross section)

Access	Easy	Difficult			
Angle	Flat	Moderate	Steep		
Vegetation	Trees	Shrubs	None		
Rock Outcrops	No	Yes	If yes, Many	Few	
Other Anchors (Ex. Fences, Utility Poles, Heavy Equip.)			No	Yes	Type_____
Mechanical Anchors Needed (Ex. Pickets, Fall-tech, Heavy Equip.)			No	Yes	Type _____

Exit Conditions

Dirt Road/Trail	**yes**	**no**	_____
Cross Country	**yes**	**no**	_____
Ropes required	**yes**	**no**	_____

Presence of Water (sketch in cross section and/or front view in Part 2) No Yes

If yes, Dry Wet Flowing

Chutes (sketch in front view) No Yes

If yes, Spacing: <20' 20' to 50' >50'

Shape/depth U shaped gentle sides U shaped steep sides V shaped steep sides

Overhangs (sketch in cross section and/or front view in Part 2) No Yes

If yes, <5' >5'

Slope Materials (sketch in cross section)

Soil Soil and Rock Rock

Rockfall Size S (<1' dia) M (1'–3' dia) L (3'-6' dia) XL (>6' dia)

Average _____ Maximum _____

Key Blocks (sketch in cross section and/or front view in Part 2) No Yes

Previously Scaled No Yes Don't Know

If yes, date_____ cubic yards scaled _____number of scalers _____number of spotters_____

Slope Scaling Assessment **Version 4.1**

Dist. _____Co. _____ Rte._____PM _____ Dir:____ ADT:_____
Slope Name: _____ Classification of Slope: _____
Preparer:_____ Reviewed By: _____ Date:_____(valid for 90 days max)

PART 2 : SLOPE DIAGRAMS

Cross Section Sketch (use range finder)	**Front View Sketch**

Legend

CL = Highway Centerline

☺ = Location of Photo

↡ = Chute

↯ = Water

↴ = Overhang

Comments : _____

Slope Scaling Assessment **Version 4.1**

Dist. _____Co. _____ Rte._____PM _____ Dir:____ ADT:_____

Slope Name: _____ Classification of Slope: _____

Preparer:_____ Reviewed By: _____ Date:_____(valid for 90 days max)

PART 3 : CLASSIFICATION SCORING SUMMARY				**Notes**
Old/New Slide	Pending Review	**Class 5**	○	
Slope Length	< 100 feet	Class 1	○	
	< 200 feet	Class 2	○	
	200 feet to 400 feet	Class 3	○	
	> 400 feet	Class 4	○	
Slope Angle	35° to 45°	Class 1	○	
	45° to 70	Class 2	○	
	> 70°	Class 3	○	
Anchor Conditions above the Slope				
Angle	Flat 0 to 20°	Class 1	○	
	Moderate 20° to 45°	Class 2	○	
	Steep >45° to 70°	Class 3	○	
	Vertical > 70°	Class 4	○	
Anchor Types	Trees	Class 1	○	
	Rock Outcrops	Class 2	○	
	Other	Class 3	○	
	Shrubs	Class 3	○	
	Mechanical	**Class 5**	○	
Slope Face Conditions				
Presence of Water	Dry	Class 1 and 2	○	
	Wet	Class 3 and 4	○	
	Flowing	**Class 5**	○	
Chutes Spacing	No chutes	Class 1	○	
	>50’	Class 2	○	
	20’ to 50’	Class 3 and 4	○	
	<20’	**Class 5**	○	
Overhangs	<5’	Class 1 to 4	○	
	>5’	**Class 5**	○	
Rock Size	S-M	Class 1 and 2	○	
	L	Class 3 and 4	○	
	XL	**Class 5**	○	
Key Blocks	No	Class 1 to 4	○	
	Yes	**Class 5**	○	

Overall Classification : _____

(Class 5 requires 2nd level review. Contact Geotechnical unit in your area for additional review)

Dist. _____Co. _____ Rte._____PM _____ Dir:____ ADT:_____
Slope Name: _____ Classification of Slope: _____
Preparer:_____ Reviewed By: _____ Date:_____(valid for 90 days max)

PART 4 : PHOTO PAGE

Scaling Crew		
Hand Scalers	**Look outs**	**Competent person on site watching slope**
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Chapter 4

Scaling

Caltrans Maintenance Manual

Rock Scaling Chapter

X.00 INTRODUCTION

Rock scaling is defined as the removal of marginally stable or unstable rocks from the face of a rock slope. Rock scaling is a maintenance management strategy that should be considered when the frequency or volume of rockfall requires additional resources beyond regular maintenance operations and other rockfall management strategies. For the purposes of this Chapter, only hand scaling methods are considered. Hand scaling is defined as scaling performed by workers suspended from ropes using hand-held pry bars or other hand tools to remove marginally stable or unstable rocks.

Scaling operations shall not be permitted unless a competent Lead Scaler, having completed the Caltrans Bank Scaling and Rock Climbing Class Refresher Training, is physically present on the site. Scaling operations shall be under the control of the competent Lead Scaler at all times. All Lead Scalers shall attend the Caltrans Bank Scaling and Rock Climbing Class Refresher Training every three years to maintain their proficiency.

> ***Note:*** Section 1540(a) of the Construction and General Industrial Safety Orders defines a *competent person* as : "One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them."

Scaling operations shall be performed in accordance with the guidelines shown in the Caltrans Bank Scaling and Rock Climbing Manual and the Caltrans Rockfall Mitigation Manual.

Supervisors and Lead Scalers shall be furnished copies of the Caltrans Bank Scaling and Rock Climbing Manual, the Caltrans Rockfall Mitigation Manual, and the Construction and General Industrial Safety Orders of the Division of Industrial Relations (CAL/OSHA), referring to "Fall Protection." They shall periodically review the Caltrans Bank Scaling and Rock Climbing Manual, the Caltrans Rockfall Mitigation Manual, the Construction and General Industrial Safety Orders, and other pertinent resources to ensure that all applicable regulations are being followed.

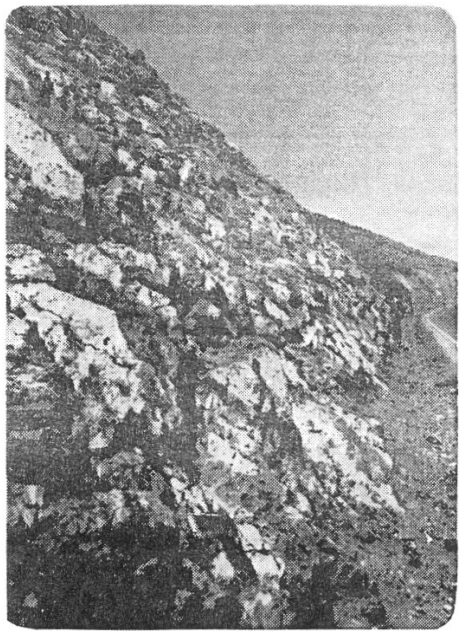
X.01 SLOPE SCALING ASSESSMENT FORM

Prior to commencement of any rock scaling operation, a Slope Scaling Assessment Form shall be prepared by a qualified/competent person. The form is designed to identify site factors as they relate to slope stability, site history, rockfall characteristics, and scaling operations. Scaling operations, if appropriate, may begin after review and approval of the form by qualified personnel from Geotechnical Services. The Slope Assessment Form shall represent the current conditions at the site and shall be revised as required if natural or other events change the conditions at the site. Scaling operations must occur within the time limits set forth in the Slope Assessment Form. A copy of the Slope Scaling Assessment Form shall be provided to each scaler, spotter, and ground control person at the site.

Caltrans Rockfall Mitigation Manual

Scaling or Trimming

Scaling is the removal of rocks and material (that are marginally stable) from the face of the slope. This is done by specially trained crews using pry bars and other tools to dislodge the rock, or it can sometimes be done by using a crane with a bucket to scrape the surface of the rock face. Trimming is the careful drilling and blasting away of overhanging rock.



Requires specially trained personnel and equipment

Scaling usually is not a permanent solution. Trimming of rock may be a permanent repair.

Scaling slopes by hand or with equipment is generally helpful for only two or three years. Maintenance forces are limited by California safety regulations; therefore, scaling on steep slopes must usually be performed by a contractor skilled in this line of work. The short time span that scaling is useful is due to the type of material and conditions that lend themselves to scaling. To successfully scale a slope, the rocks must be in a weak matrix that erodes and, thus, exposes new rock; or the rock is separated by numerous discontinuities to such extent that scaling can be useful; or there are individual loose rocks resting on ledges of bedrock. The latter example is commonly found on slopes that were overshot during construction or where freeze-thaw in an irregular face has caused rocks to move a short distance. Scaling of natural slopes, such as glacial deposits, above the road could encompass extensive work due to the large area that may be involved.

REMOVAL OF POTENTIALLY UNSTABLE BLOCKS BY SCALING

Scaling is a form of excavation used principally to remove loose or unstable rocks from a slope face. It is used on both natural and man-made slopes and is one of the most commonly used rock slope maintenance measures. Due to the ongoing weathering and relaxation of surficial blocks, scaling improvements are temporal and must be repeated periodically. It requires experienced personnel to be safe and effective. There are two basic approaches to scaling – hand scaling and mechanical scaling.

Hand scaling is done by workers suspended from ropes or working out of a crane or lift basket using hand-held pry bars. Slopes are always scaled from the top down for safety. The surface of the slope is evaluated and loose blocks that have the potential to fall are pried off the slope. This is an important distinction, since not all rocks that can be moved with a pry bar have the potential to fall. Hand scaling may be augmented using power-assisted mechanical equipment such as air pillows or splitters that are inserted into open cracks then expanded.

Scaling is performed in a controlled manner with traffic or other access beneath the scaling area prohibited, unless additional barriers or other forms of effective protection are in place. However, due to the erratic behavior of rockfalls, it is best to do scaling under temporary road closures with traffic queues allowed to clear when scaling is halted. Still, additional temporary protection may be required depending on down slope facilities, utilities and structures.

Figure 13-29. Routine hand scaling operation. (*Photograph courtesy of T. Badger*)

When scaling is performed using power equipment such as hydraulic hammers or backhoes, the method is termed mechanical scaling. Mechanical scaling may be a more efficient method of removing unstable blocks, but final checking and hand scaling of the finished slope is usually still required (Federal Highway Administration, 1993). Figure 13-30 shows mechanical scaling using a hydraulic hammer. Other common mechanical scaling methods include dragging a heavy object, such as a blasting mat or cat track, across the slope to abrade loose rocks.

Figure 13-30. Mechanical scaling using a hydraulic hammer (*Photograph courtesy of T. Badger*)

Scaling can also be performed using strategically placed explosives in cracks or drilled holes, or by using heavy construction equipment such as a trackhoe. It should be noted that without confinement, "crack blasting," the hand-loading of explosives into open cracks, can be relatively ineffective and dangerous; it may only produce loud explosions and fly rock.

In all cases, scaling operations should be observed and carefully controlled to prevent concentrated scaling that can lead to unsupported or over steepened slope areas. This is particularly true when using heavy equipment capable of excavating the slope.

Scaling may only be effective for a period of 2-10 years depending on site conditions; so it should not be considered a permanent mitigation measure. In some cases, due to localized slope disturbances, rockfall activity may slightly increase immediately following scaling. However, scaling is relatively inexpensive and overall is an effective rockfall mitigation technique. It is routinely used prior to constructing other mitigation efforts, such as rock bolts or draped mesh, or on newly excavated rock cuts to remove loose rocks that clearly pose a risk.

FHWA Rockfall Manual

7.2.1. Scaling

Scaling is an effective way to remove overhanging, protruding rocks or unstable rocks. Scaling methods are numerous and a site evaluation will determine the most cost- effective procedure for the program. Scaling at crests and on the faces of high steep slopes must be carried out by experienced personnel. The work will be performed from ropes or in a basket hanging from a boom with pry bars, hydraulic splitters or jacks, and small-scale explosives or chemical expanders, such as S-Mite or Bristar .

Mechanical scaling, such as dragging a cat track across the slope with the use of a boom crane, is generally a much quicker and safer method, but final hand scaling for remnant unstable rocks is still required. Mechanical methods such as the mechanical rock breaker, or the use of exploding shells from a howitzer, or high-pressure water monitoring, have been used to remove unstable material. The latter allows for remote scaling. It is more commonly used for snow avalanche control.

Periodic scaling should be performed as required on some slopes. Where numerous freeze-thaw cycles occur, scaling every 8 to 10 years is desirable. In dry warm climates, scaling cycles every 12 to 15 years may be adequate. Scaling must be performed thoroughly so it is not required every several years. While it is an interim mitigation method, it is also usually the least expensive mitigation procedure. In temperate climates, such as those found in the northwest, central and eastern U.S., scaling should begin in the spring after the frost leaves the rock. Rockfall frequency is usually greater during heavy precipitation, during high winds if trees are on the slope or crest, and during spring melt.

A scaling crew will normally comprise 2 to 4 members, depending on their support method. One equipment operator, who is usually the supervisor will clear the road and load the rock. There will be a truck on call. A crane and operator also may be used to lift a basket from which scaling is performed.

A common technique to protect the roadway during scaling is to cover the road with soil and build an earth berm to control the rolling rocks. Rockfall runout control at the highway must be provided. Procedures for this are described later. Traffic control at the highway must be developed. Scaling will usually have to coincide with periods of low traffic flow. Where traffic is extremely heavy, a detour may be required.

Draft nSSP

78-X MECHANICAL SCALING OR HAND ROCK SLOPE SCALING

78-X.01 GENERAL

78-X.01A Summary

1

Section 78-X includes specifications for removing loose rock and material from the slope face and providing rockfall runout control at the highway at locations shown.

2

78-X.01.B Submittals

78-X.01B(1) General

3

Submit evidence that rock scaling personnel involved in this project are trained in and have worked as a mechanical rock scaler. The foreman must have demonstrated experience as a rock slope scaling foreman. The rock scaler must have demonstrated experience on similar projects.

78-X.01B(2) Work Plan

4

The plan includes:

1. Proposed construction sequence and schedule
2. Type of equipment and tools to be used.
3. Number and distribution of foremen, equipment and operators scalers and lookouts.
4. Rock removal and disposal plan for the rock and debris generated from the rock scaling work, the rockfall runout control, including provisions to protect the highway and adjacent facilities.

78-X.02 MATERIALS

5

Not Used

78-X.03 CONSTRUCTION

6

Start rock scaling operations at the top of the work area as shown and proceed downward towards the highway removing all loose rock material as the work progresses.

7

The scaled face must be inspected and approved as completed. Dispose of rock and debris generated from the scaling operations.

78-X.04 PAYMENT

8

Not Used

Caltrans Bank Scaling and Rock Climbing Training

GUIDELINES FOR DEVELOPING A SCALING PROGRAM

1. Identify Highway Slopes Prone to Rockfall
    - Request information from Maintenance Area Supervisors and Lead Workers
    - Identify chronic rockfall areas and prioritize sites
    - Collect basic site specific data such as :
        - Access for climbers
            - can climbers safely access the top of the slope?
            - is there an access road?
        - Anchor quality and quantity
            - what kind of natural anchors exist for climbers? (trees and rocks)
            - are there enough natural anchors in the right places?
            - if little or no natural anchors exist, install artificial anchorage. (pickets, Manta Rays)
        - Maximum slope height and total length of slope to be scaled
            - height determines the rope length required
            - length determines the number of scalers and the spacing interval
        - Typical rock size and expected quantity of material generated
            - rock size determines the type of scaling tools to use, are digging bars necessary?
            - quantity determines the type of load and haul operation to plan.
        - Frequency of rockfall
            - this determines the required frequency of scaling and possible permanent mitigation
        - Traffic control considerations
            - no scaling without traffic control. No exceptions.
            - both directions of the route must be closed intermittently during scaling ops.
            - if possible, both directions of the route are reopened simultaneously to expedite clearing of traffic.
            - should lane closure charts be requested? YES, always. Scaling can be very disruptive to public traffic.
            - is a detour available? If so consider full closure and detour traffic during scaling ops.
        - Public affairs issues
            - delay to the public should be expected, typically 30-45 minutes or more.
            - give PIO at least 1 week advance notice prior to scaling operations

2. Request Site Evaluations from qualified Geotechnical Personnel
    - Get concurrence on the applicability of scaling at each site. Prepare a Slope Scaling Assessment Form for each site.
    - Conduct a pre-scaling reconnaissance meeting with the Geotechnical representative at each proposed scaling site.
    - Establish a history of geotechnical study at the site.
    - Request follow-up scaling or mitigation studies if necessary.
        - does the site warrant a permanent rockfall mitigation project?

3. Maintain a Data Base of Scalers and a Current Climbing Gear List
    - Identify District scalers by name and Maintenance Station
    - Include personnel who have attended the training in Kingvale
    - Identify prospective climbers for future training and scaling operations
    - Identify a lead scaler for each site
        - The lead scaler must be a qualified person who is experienced and familiar with
        - the operation and the hazards involved
    - Maintain a current list of required climbing gear with vendors information and current prices
        - Each scaler must maintain a Personal Climbing Log
        - Each scaler must have the appropriate gear
        - Each scaler must have rope and scaling tools
        - Scaling tools include shovels, digging bars and ice axes.

4. Maintain a Data Base of Scaled Sites
    - Document the date, number of scalers and lead scaler
    - Together with Geotechnical personnel, determine the frequency of scaling required at each site.
    - Log the Slope Scaling Assessment Form for each site.
    - Document the type and quantity of rockfall mitigation recommended or employed, if any.

Caltrans Bank Scaling and Rock Climbing Training

Scaling Operations

SITE RECON MEETING CHECKLIST

TRAFFIC CONTROL CONSIDERATIONS

- ☐ CMS's should be used to alert motorists of delay in advance of operation. 30-45 min. delay is normal.
- ☐ Highway is closed in both directions and re-opened in both directions (if possible) to clear traffic faster.
- ☐ Typically scale 10-15 minutes, allow 10-15 minutes clean-up, then re-open lanes. Repeat as necessary.
- ☐ Radio Communication must be in place between the lead scaler(s) on the slope and ground control.
- ☐ Radio Communication must be in place between ground control and the flaggers.
- ☐ Determine if intermediate flaggers are required to prevent errant vehicles in the work area.
- ☐ Never scale or climb the slope without traffic control in place.

SCALING/CLIMBING CONSIDERATIONS

- ☐ Slope Assessment form is completed by competent/qualified personnel
- ☐ Determine the access route to the top of the slope.
- ☐ Identify site specific natural hazards such as snakes, ticks, poison oak etc.
- ☐ Assess anchoring conditions prior to the day of scaling.
- ☐ Artificial anchors can be installed if necessary. This may require a separate 1 day operation.
- ☐ All anchors must be double checked by the lead scaler(s) prior to first rappel.
- ☐ Installation of edge protection must be assessed.
- ☐ Spacing interval of scalers, typically 20-40 feet but is site specific.
- ☐ Competent person on site to observe slope during scaling operations.
- ☐ Use of "spotters" at the top, sides, or bottom of the slope to warn of incidental rockfall.
- ☐ All scalers must be Kingvale trained, competent and physically fit and a volunteer for this type of duty.
- ☐ All scalers should provide their own climbing gear, rope and scaling tool.
- ☐ The Rescue 8/Ascender combo rappel method must be used when scaling. No exceptions.
- ☐ All scalers descend at the same rate and stay at the same elevation on the slope.
- ☐ All scalers remain still during clean-up operations and periods of live traffic below.
- ☐ The best scaling tool is a long (80 cm) ice axe. Available at REI.
- ☐ Other scaling tools include short shovels and short digging bars.
- ☐ All scalers must use a climbing helmet with chin strap, not a hard hat.
- ☐ Standard PPE's such as boots, gloves, and safety glasses must be used.
- ☐ Other personal protective equipment such as dust masks, shin guards and gators are recommended.
- ☐ All scalers should bring water and snack food. A camel back is recommended.

GROUND CONTROL CONSIDERATIONS

- ☐ Identify haul site. Be prepared to remove large amounts of rock and dirt quickly.
- ☐ If possible, short haul to stockpile, then remove to final disposal site at a later date.
- ☐ Secure at least one loader, one dump truck and a plow truck to clear the roadway quickly.
- ☐ A power broom or sweeper is nice if available.

GENERAL SAFETY CONSIDERATIONS

- ☐ Identify the location of the nearest medical facility, have a map ready if in remote or unfamiliar area.
- ☐ Identify personnel on site who are trained in First Aid.
- ☐ Identify personnel on site who are trained in Aerial Rescue for an ambulatory victim.
- ☐ Identify a vehicle to be used to transport a victim in case of emergency.
- ☐ If an injury requires a victim be removed from the slope, call 911 and request a "High Angle Rescue."
- ☐ Prepare a Tailgate Safety Meeting Agenda and Sign in Sheet. Conduct a Safety Meeting before each

Caltrans Bank Scaling and Rock Climbing Training

Summary

What is Rock Scaling?

- Scaling is the removal of loose rocks using hand tools and pry bars.
- Rock Climbers call it trundling.
- The Allied forces in Afghanistan used it as a weapon.
- Caltrans Maintenance and Geotechnical volunteers call it hard dusty rewarding work

When is scaling appropriate?

- Scaling is not “a random act of engineering” but is an organized, deliberate discipline founded on geologic and engineering principles and is a technique used throughout the world.

Why Scale?

- All slopes age.
- The aging process eventually weakens the surface resulting in loose blocks of rock.
- In time, just as with structures, the slope surfaces need maintenance.
- Rock patrols and rock scaling are typically the first line of defense.

When to Scale

- Every slope is different and is distinguished by
    - size
    - character
    - properties
- Assessing these characteristics falls to the responsibility of
    - maintenance personnel
    - engineering geologists
- Together rockfall characteristics are evaluated and the decision of when to scale or not to scale is made.

How is it done and by whom?

- Transcontinental Railroad Era Chinese and Irish laborers moved loose rocks
- During the great dam projects workers hung onto ropes with their bare hands
- Caltrans rock scalers using a blend of industrial and recreational climbing techniques

Scaling and Climbing as a Resource

- Emergency response.
- Site Inspection
- Scaling Operations
- Regular maintenance.
- Periodic Scaling of trouble slopes
- Slope investigations

Caltrans scaling training program is the only one of its kind

- Caltrans regularly receives inquires from across the US and abroad.
- Caltrans scaling teams have been featured in the National Geographic special “Landslides” and the Learning Channel Special “Disasters Detectives.”
- It is truly a unique program enabling Caltrans to employ best management practices for slope maintenance.

Caltrans Bank Scaling and Rock Climbing Training

Chapter 5

Equipment

PERSONAL PROTECTIVE EQUIPMENT

CLIMBING HELMETS

A climbing helmet is required for all bank scaling and rock climbing activities. A Caltrans hardhat, with a chinstrap is better than nothing, but it is not an acceptable substitute for a climbing helmet.

The helmet is one of your most important pieces of equipment as it protects the grey matter between your ears. Head injuries are a major cause of death or serious injury to climbers. There isn't much more to say here other than good old Murphy's Law *can* take effect at any time and if it can happen…it will.

One thing you don't need to worry about when choosing a climbing helmet is its strength…get one approved by the U.I.A.A. Their labs simulate rock fall by dropping steel balls and pointed anvils several feet onto a helmet strapped onto a hardwood dummy. They also smash the front, back and sides of the helmet and try to rip off its chinstraps.

Other important considerations when selecting a helmet are ventilation, stability, weight (the mean is 15 ounces), and comfort. Everyone's noggin is different, so try on several helmets, with and without a hat, before buying. Make sure the helmet does not flop around if the straps loosen slightly. U.I.A.A. helmets must also meet ventilation and material standards.

The U.I.A.A. label doesn't say one helmet is stronger than another, nor does it rate helmets for certain purposes, such as ice climbing or rock climbing. It does say, when properly used, the helmet should protect your head from serious blows.

GLOVES

Refer to the Caltrans Safety Manual, Chapter 12.09 Hand and Arm Protection.

For the beginning climber, gloves may mask the heat that is generated during a rappel. For this reason, we do not allow beginning students to wear gloves during the first morning of rappelling. Feeling the heat on your bare hands gives you an idea of how much heat can be generated from friction on the rope.

More experienced climbers may wear gloves to protect their hands. Be sure that the gloves are a good fit. Loose fitting gloves can make it difficult to operate gear and can even snag during a rappel.

SAFETY GLASSES

Refer to the Caltrans Safety Manual, Chapter 12.06 - Eye and Face Protection

The State warehouse carries different styles of safety glasses. Safety glasses are necessary when working on slopes. Rocks can be dislodged by the rope above you. When belaying someone from below, the climber could accidentally kick rocks down towards you. It is important to be able to look up and spot any incoming objects in order to avoid them.

SHIN GUARDS

Shin guards are **highly recommended** during a scaling operation. If you've ever felt the pain of being kicked in the shin, you know its not a pleasant feeling. If you aren't wearing shin guards, or Kevlar gators, you are just inviting small rocks to come down and hit you. Anything from soccer shin guards to the hard plastic guards worn by hockey goalies will work.

HARNESS

Have you ever hung from a rope around your waist? If you have, you know that it is not a nice experience. A harness serves as a comfortable and reliable way to connect your body to a rope. The harness allows you to hang from a single point as it distributes the force of your weight across your legs and waist by means of thick webbing. Harnesses come in many styles and types. Selecting the proper harness for the type of work you will be doing is very important. Factors to consider when choosing a harness include, comfort, durability, reliability and cost. Remember during a scaling operation, you may be spending all day, for several days in a row, hanging in the harness. You will want a harness that fits well and remains comfortable for long periods of time.

There are several different styles of harnesses out there but whichever one you chose, when you are suspended from it you should stay in an upright position. An optional chest harness will help, with the trade-off of adding weight and bulk to the system.

> When sizing your harnesses, ensure that the webbing is double-backed through all load-carrying buckles with at least 3 inches of webbing extending beyond the buckle.

Pictured below are some of the harnesses currently being used by your colleagues at Caltrans.

Caring for your Harness:

- **Inspect your harness for wear spots after every use.**
- **When avoidable, do not lend your harness to others. Everyone uses equipment differently.**
- **The CT Climbers Harness Inspection form should be completed and stored with the harness.**

CT Climbing Harness Inspection Form

Inspector (Primary User): _____ Date: _____

Inspector (Co-worker/Supervisor): _____

Harness Manufacturer, Model & Serial Number: _____

Harness Checklist:

Examine each component for signs of damage. In non-metal stitched components, look for fraying, splits, stains, weathering, lack of suppleness, and other signs of wear. In metal and plastic components, look for cracks, grooving, warping, and other signs of wear.

Items to be checked:	Yes (OK)	No (Give descriptions)
Belay Loop		
Harness Belt		
Leg and Crotch Loops		
Primary Attachment Points		
Buckles		
Leg Loop Connectors		
Tool Attachment Points		
Label Markings		

Comments:

_____

_____

_____

_____

User Checklist:

Has user received training on proper use of harness? _____

Date of last training: _____

Does harness fit properly? _____

Signature: _____

RAPPEL AND BELAY DEVICES

The old days of body belays and rappelling are just that, old. Today's belay devices and rappel devices are really nothing more than a friction device. They introduce enough friction to allow a controlled decent on a rope. Like all tools used in scaling, a climber must be trained in the proper use of a rappel device. This is especially important since often times, **this device will be the primary connection between a climber and his rope.**

The standard rappel device for bank scaling operations is the Rescue 8 device. The Rescue 8, a variation of the Figure 8 rappel device, has "wings" or "ears" that can help prevent jams as the rope passes through it. It can be made of steel or aluminum. Steel is generally stronger, and will be rated to carry heavier loads. Aluminum devices have the benefits of being lighter and more efficient in dissipating heat.

To set up a Rescue 8 for rappel, the climber passes a bight of rope through the large opening, and brings the bight over the smaller end of the 8. The Rescue 8 is then connected to a primary connection point on the climber's harness using a locking carabiner. This "wrap" of the Rescue 8 creates the friction necessary for a controlled descent. Climbers may also bring the bight through the opening a second time for a "double wrap" that creates even more friction for greater control (See Chapter 9, Working On Rope).

There are many other rappel devices on the market. However, Caltrans recommends using a Rescue 8 rappel device for scaling operations.

A belay device, generally has two functions. The first is to allow rope to be fed through the device relatively freely, so that a climber on belay has the freedom to move around without restriction. The second function is to provide the belayer the means to quickly stop the descent of the climber in case of a fall. Because a belay device serves two functions, the belay must be tended vigilantly by the belayer; giving the climber enough slack rope to maneuver, but immediately ready to take up the slack and prevent a climber from falling.

Some descenders can also be used as belay devices; but make sure they have been approved for belaying. A Rescue 8 may be used as a belay device. Again, proper training to use the device correctly is important. **Be sure to use the small opening of the device when belaying with a Rescue 8 - the large opening of the device DOES NOT produce enough friction to stop a fall.**

The Caltrans primary method is to a belay using a Munter-mule hitch (See Chapter 7, Knots and Hitches) on a carabiner. The Munter-mule hitch wraps and pinches the rope to provide friction. The hitch can be tended to serve the same functions as a belay device. **One important feature of both rappel and belay devices, is that they must be able to be "locked off." When a device is locked off, rope is no longer allowed to pass through the device, preventing further descent of the climber.** The Munter hitch provides the friction for control; and the Mule knot can be used to lock off the belay. This is the method taught in this course.

Caring for your Rescue 8:

Friction and heat can cause damage to a Rescue 8. Be sure to inspect it for any cracks before and after use. Take care not to drop it. Dirt can increase the wear on the device, so care should be taken to keep dirt away from it. This applies to both the device and any rope passing though it (See Chapter 6, Rope). Grooving is a natural result from the friction it is exposed to. Keep in mind the strength of the device is directly proportional to the amount of metal remaining. In other words, if a groove has worn 1/4 of the way through the metal, the strength of the device is only 3/4 of its full strength. Retire the Rescue 8, if there is too much

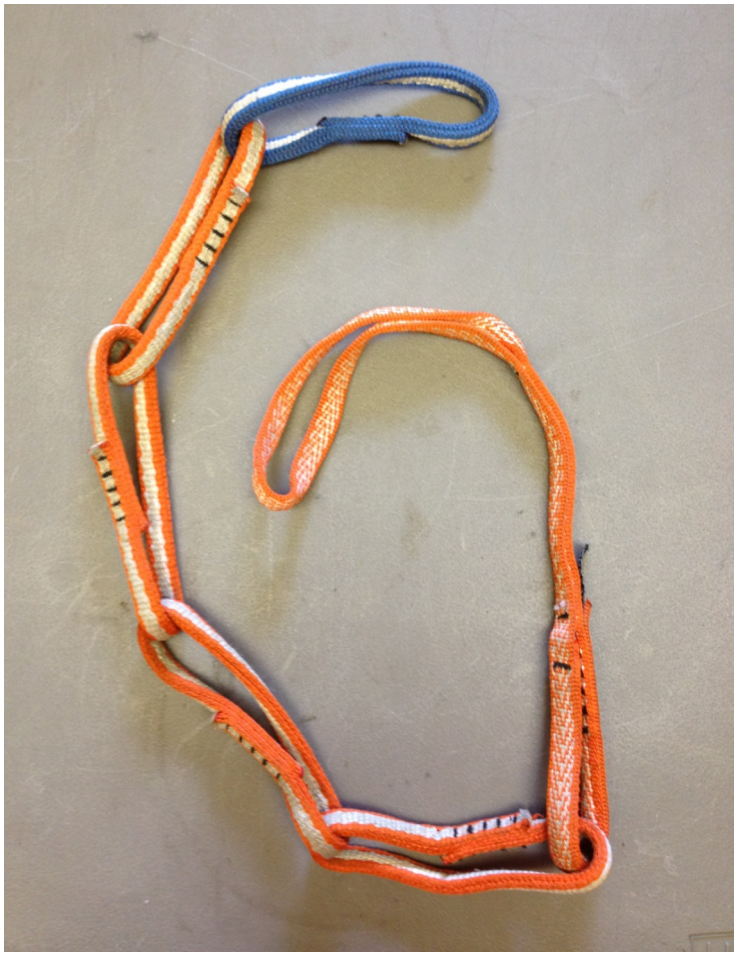
DAISY CHAINS (PERSONAL ANCHORING SYSTEMS)

(This section is under development)

The Caltrans approved daisy chains are:

Knotted daisy chains

Hand -tied with 9/16th inch or 1 in webbing



Individually sewn loops.

Looped daisy chains

ASCENDERS

Ascenders are used to make upward progression on a rope. An ascender has a rope guide and a camming rope clamp. When the rope is in the rope guide and the cam is activated, the cam allows the ascender to slide in only one direction along the rope. With two ascenders on the same rope, a climber can ascend by alternating putting his weight on one ascender while sliding the other ascender upwards. Training and technique are important to efficiently traverse upwards on a rope.

Ascenders usually come in pairs; one for the right hand and one for the left. They are designed for one-handed operation. When holding the ascender in the correct hand, you should be able to open and close the cam with your thumb. There is also a safety lever that can keep the cam from opening fully, or lock the cam in the open position. Larger ascenders come with a molded hand grip for comfort and ease of use.

It is important that the ascenders you use are correct for the size rope you are climbing on. The CMI Large Ultrascender is designed for use on rope between 8.5mm and 16mm diameter.

A single ascender, when used correctly, may be used as a "self-belay." A climber **must** be properly trained to use an ascender for this purpose, as this is considered a "Life" connection.

CMI Large Ultrascender

One right and one left handed ascender, each with two 9/16" webbing slings 30" long.

Caring for your Ascenders

Clean ASCENDERS with a mild detergent solution or disinfectant after use and dry, if necessary. *Cleaning and drying should be carried out immediately after every use in a marine environment.*

Store in a clean dry environment avoiding extremes of temperature, corrosive fumes or chemical substances. *If the ascender is exposed to chemicals, refer to chemical data sheets and/or the manufacturer.*

Do not use the ascender in extremely cold weather if there is a possibility of water or ice coming into contact with the ascender's moving parts. In these conditions, an alternative is to use prusik knots.

It is recommended that you examine the general condition and function of the ascender at least yearly.

It is difficult to estimate the lifespan of the ascender due to variations in use and care, but in normal usage, and with regular cleaning and lubrication, it should be more than five years.

CARABINERS

All carabiners under impact loads shall withstand a 5000-pound tensile test without fail. **Refer to ANSI A10.14-1975**

Carabiners are metal clips used to make an almost unlimited array of connections between rope, webbing, harnesses and other gear. Carabiners can be classified into two main categories, locking and non-locking.

As with other equipment, we recognize in carabiners a difference between sport climbing and rescue operations. In rescue, higher static loads are involved; personnel management and rope management becomes more complicated. Caltrans has developed a protocol for the most appropriate carabiners to be used in Caltrans slope climbing activities.

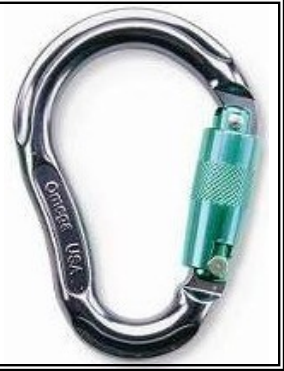
Application dictates the type of carabiner to be used. A locking carabiner is required for the connection between the harness and the descender device. A single locking carabiner or two opposite and opposed non-locking carabiners, at a minimum, are to be used for all life-supporting connections. Single non-locking carabiners may be used for directionals or other non-life-supporting connections.

For the greatest strength, the load applied to a carabiner should be along its major axis. A carabiner is one third as strong along its short or minor axis. The gate of the carabiner is not intended to take a load. The gate of a carabiner should remain closed at all times to ensure maximum strength. An open carabiner is about one third as strong as a closed one.

Please see the Chapter 2 Safety, Rope Work for more information concerning the safe use and care of carabiners. Avoid metal to metal connections whenever possible.

Swing Gate Auto-Locking "D"

Large Locking "D" with gate that opens on an angle for easier accessibility. Opening auto-locking carabiner requires an action to unlock the gate; then a separate action to open the gate.



Standard Oval

The standard workhorse is a non-locking drop forged aluminum carabiner.

Manual Locking "D"

Large locking "D" with gate that requires a dedicated action to lock and unlock the gate.

CT Climbers should have at least 4 locking and 6 non-locking carabiners

Caring for your Carabiners

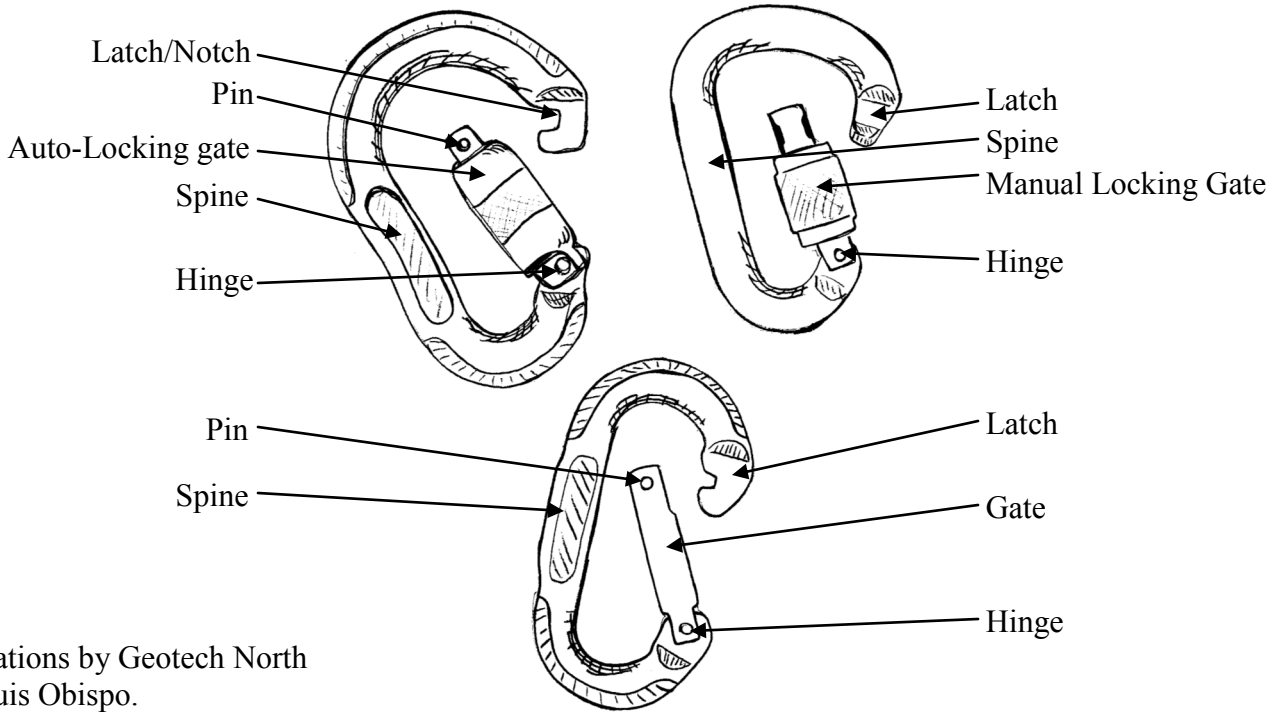
Clean carabiners with a mild detergent solution or disinfectant after use and dry, if necessary. *Cleaning and drying should be carried out immediately after every use in a marine environment.*

Store in a clean dry environment avoiding extremes of temperature, corrosive fumes or chemical substances. *If the carabiner is exposed to chemicals, refer to chemical data sheets and/or the manufacturer.*

Carabiners

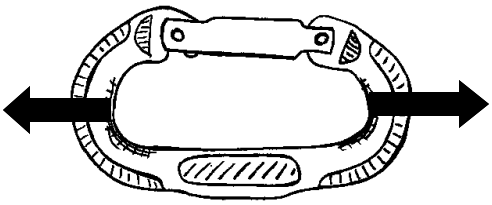
Function: Carabiners are designed to take the load on their long axis. Any loading different than this will reduce the strength of the carabiner. The gate of the carabiner is not intended to take a load.

Parts of a Non-Locking and Locking Carabiner

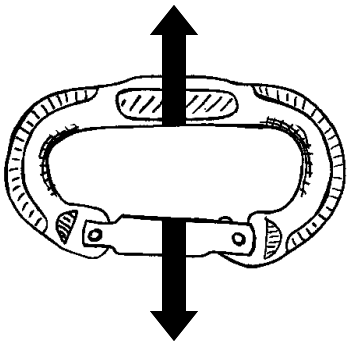


Illustrations by Geotech North San Luis Obispo.

Carabiner Loading



Strongest: Carabiner loaded on the long, or major axis



Weakest: Carabiner loaded on the short or minor axis

Carabiner Strength

The strongest direction to load a carabiner is along its major axis. This puts the load along the solid side and through the pins and gate. This is the ay carabiners are designed to be pulled. Pulling along the minor axis can reduce the strength by as much as 50%. An open gate reduces the strength of a carabiner by as much as 75%. In critical applications, two carabiners may be used together, with gates opposite on opposed sides to give double the strength and increase security against accidental gate opening.

NYLON WEBBING & 7mm ACCESSORY CORD

Nylon webbing is lightweight and has multiple uses. We like to use webbing for tying anchors since its wide surface area provides a good grip on the anchor point and provides high abrasion resistance.

For the same length, rope has more bulk than webbing. Some rescue squads use short lengths of rope to tie anchors. If a long extension is needed from the anchor to where you want to attach the system, use a rescue rope, rather than lengths of web or smaller lines tied together.

Accessory cord is also lightweight and has multiple uses. Accessory cord can also be used to tie anchors when abrasion is not a factor. For example, if artificial protection is used to build an anchor, the protection may be placed so the cord will not have to make contact with the ground.

- Each climber should have at least 50 feet of the 7mm cord available for various uses.
- Inspect all cord before using it.
- Each climber should have at least 100 feet of the 1" webbing and about 30 feet of the 9/16" webbing, available for various uses.
- Inspect all webbing before using it.
- Webbing may be marked with things like, year in service, or your initials.

Uses for webbing and cord include:

- Tied daisy chains
- Webbing Sling
- Connection between ascender and carabiner
- Anchor points (and Multipoint anchors)
- Emergency harness
- Basket hitch connection
- Girth hitch connections
- Cord Sling (Cordelette)
- Prusik (or other friction hitch) connection to climbing rope
- Accessory rope

There are hundreds of other possible uses for both webbing and cord, way too many to list here.

SUMMARY

Personal Protective Equipment.

- Helmets must have chinstrap to prevent helmet from falling off.
- Safety glasses when going down scaly slope or belaying someone from below.
- Warehouse carries different styles of safety glasses.
- Loose gloves can jam a rappel device.
- Shin guards are highly recommended during scaling operations.

Harness

- Check the fit of your harness
- Check the components of your harness: Buckles, leg loops, accessory loops, and waist support.
- Care for harness.
  - Inspect harness for wear spots after every use.
  - Do not lend others your harness. Everyone uses equipment differently.

Rappel and Belay devices

- A Rescue "8" is the recommended rappel device for scaling operations
- Some descenders can be used to belay climbers
- Must be able to lock off device
- A munter-mule hitch is the CT recommended method of belaying.

Daisy Chains (Personal anchoring systems)

- Use only CT approved daisy chains.

Ascenders

- One right and one left handed ascenders.

Carabiners – Locking and regular (non-locking).

- Should have at least 6 non-locking and 4 locking.

Nylon webbing

- Should have at least 100' of the 1" and about 50' of the 9/16", for various uses.
- Mark all webbing with year and initials.
- Inspect all webbing before using it.

7mm Cord

- Should have at least 50', for various uses.

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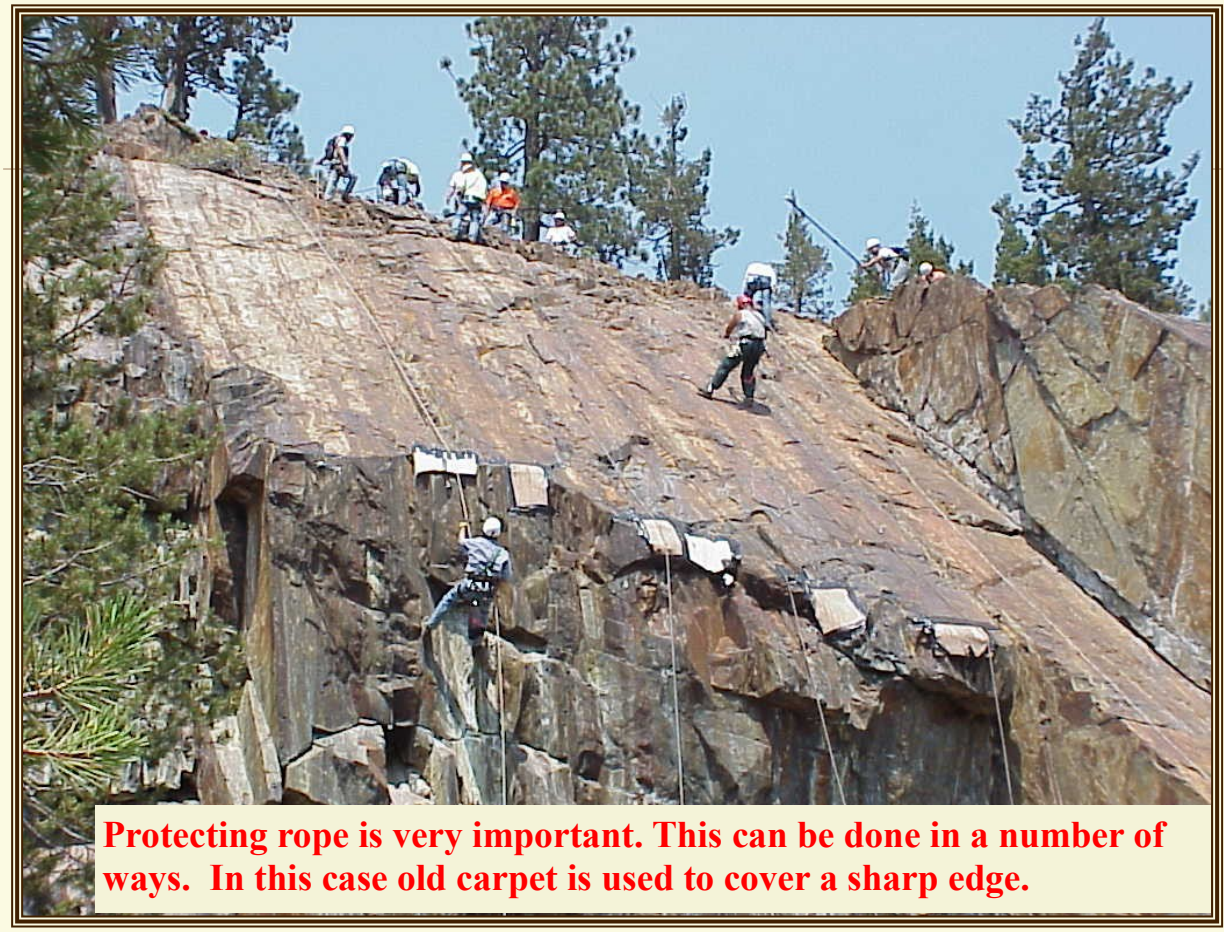
Chapter 6

Rope



Protecting rope is very important. This can be done in a number of ways. In this case old carpet is used to cover a sharp edge.

ROPE

A rope can be dead weight on the approach and an indispensable lifeline on the climb. It serves as a link in the communication between climber and belayer-its subtle tugs and jerks relaying the progress of a partner out of sight and hearing. A rope is cursed when it tangles, praised when it holds, and on occasion has the annoying habit of being just a few feet too short at the wrong time.

For bank scaling, we use Safety Blue Rope rated at 7000lb.

New England Safety Blue rope is a 1/2 inch (12.7mm) diameter static kernmantle rope. It gets its name from the blue inner core of the rope. The outer sheath covers the inner core, so if you can see the blue through the sheath, it's time to retire the rope. It is UIAA approved.

CONSTRUCTION

Lay and braided are two basic styles of rope construction. The type of material and the number of strands used to construct the rope generally determine the strength of the rope. Common natural fibers used to make rope include hemp, linen, cotton, jute and straw. Common synthetic fibers include nylon, polyesters and polyethylene.

Lay ropes

Lay (also called laid) rope refers to the construction method of rope used throughout history. It consist of three or more strands of fiber twisted together in one direction to "lay" the rope. This type of rope may be used for very mild slopes where you need just a little help walking up or down the slope.

Braided ropes

In braided ropes, multiple fibers are woven together in opposite directions to form the rope. This type of construction allows different properties to be built into rope. Using different synthetic materials can allow the rope to be stronger, more elastic, more water resistant, or more flexible.

Kernmantle ropes

In kernmantle ropes, the "mantle" is a woven sheath of nylon over the "kern," or core, of twisted strands. The mantle contributes about one-third of the rope's strength, but its main function is to absorb the abrasion that would be continually weakening the inner core, which provides most of the strength. It provides a smooth, uniform surface that reduces friction over rock and through carabiners. Kernmantle ropes are flexible, easy to handle, and hold knots well. While more expensive than lay ropes, they have many advantageous features for the technical climber. It is very important to inspect kernmantle ropes often, especially in a lifeline application, since damage to the kern may not be visible through the mantle. Sometimes a flat or soft spot under the sheath can be felt, which could indicate there is damage to the core..

Kernmantle vs. Lay ropes

- Lay ropes lack a protective sheath
- Kernmantle ropes can be constructed with different properties for different proposes
- Lay ropes tend to untwist when loaded, causing loads to spin
- **If the core of a kernmantle rope is damaged, it can be hard to detect!**

Standard Rope Types

Three strand or laid rope

Static, kernmantle rope showing core (kern) and sheath (mantle).

Dynamic, kernmantle rope used for rock climbing.

Double braid rope showing the braided sheath and braided core.

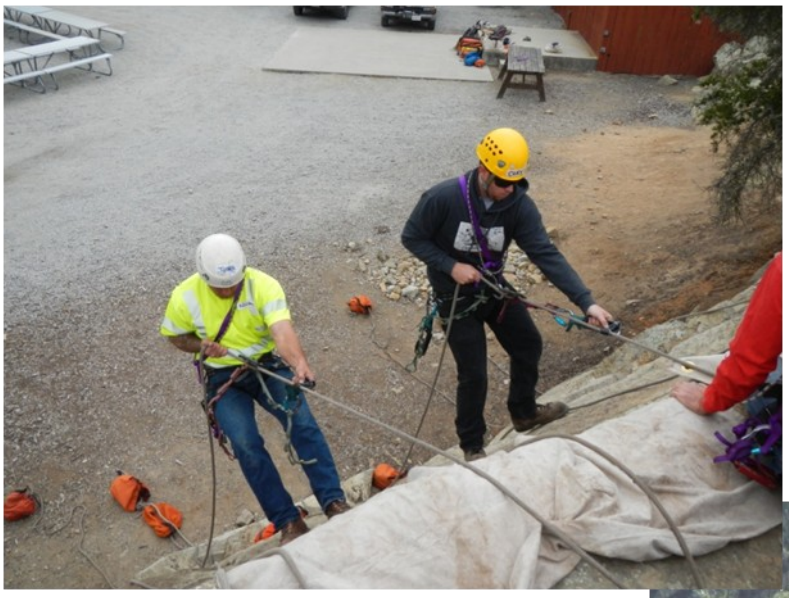
STATIC vs. DYNAMIC ROPE

Simply put, dynamic rope stretches while static rope does not. Technically, all ropes have a little bit of stretch when you put a load onto them, even static ropes. However, dynamic rope is specially constructed to have more elasticity. In the climbing community, you will hear a lot about how important it is to use dynamic rope. Dynamic ropes stretch when loaded, so they can soften the impact of a fall, reducing the shock on the body. This is important when the main function of the rope is for fall arrest.

Static rope is more applicable in rappelling and ascending operations. They are also the preferred rope for rescue operations. Static ropes reduce bouncing and allow for more control while descending. While ascending, nothing is more disheartening than making the effort to ascend a few feet, only to have the rope stretch back down to where you just were.

EDGE PROTECTION

In our class we take rope guarding very seriously. We use a combination of Velcro, canvas, plastic and metal roller caterpillar edge guards at various locations throughout our practice facility. Every climber should have access to some form of edge protection for use when they climb. Even an improvised form of edge protection is better than nothing. If nothing else is available, a canvas rope bag or even a spare shirt can be strategically placed to protect the rope from a sharp edge.



ROPE MAINTENANCE

Rope maintenance is very simple. If you are storing them, keep them in a dark, cool, dry place so that they don't get sun damaged and/or moldy. As a rule of thumb, you should not use a rope any more than five (5) years.

In rappelling, caving, and rescue applications it is important to take measures to protect the rope. Always take care to rig the rope safely and pad any places where it could be cut or abraded. Avoid dragging the rope from side to side under tension as the rock may abrade or saw through it. A rope under tension will abrade much more quickly than one that is not. Bouncing on your rope may also cause abrasion. It is also important to rappel slowly and in control. Fast bounding rappels are not only unsafe, but can generate enough heat through friction with the rappel device to melt or glaze the sheath of the rope. Once a rope is glazed; it loses a considerable amount of its flexibility and strength.

- **Avoid stepping on your rope as a matter of good housekeeping** even though recent testing has shown that dirt in the rope fabric does not weaken the rope.
- **Do not use climbing ropes for hauling** or for any purpose except climbing operations.
- **Do not splice climbing ropes.** Use a bend knot to connect to two ropes.

KEEP YOUR ROPE CLEAN

One of the biggest things you can do to extend the life of your rope is to keep it clean. To keep your rope clean, minimize its contact with the ground. Keep the rope in a rope bag when not in use. If you need to access the entire rope (to find the middle, to use both ends of the rope, …) pour the rope onto a tarp or a clean rock surface. Even the chemicals in concrete and asphalt, especially hot asphalt, are a concern. The chemicals and oils can leech into the rope and weaken it over time. Keeping your rope clean will give it longer life.

- Clean your rope when it becomes dusty, muddy, or dirty.
- Wash your rope in a washing machine using very mild detergent, such as Ivory.
- DO NOT dry your rope in the dryer. This will damage the rope but the damage will be undetectable.
- Hang your rope to air dry...out of direct sunlight.

You should retire the rope if it has:

- Been in use for more than five years
- Been used to haul a boat, or similar
- Taken any large falls
- The blue core visible through the sheath
- A soft or flat spot under the sheath

STORING YOUR ROPE

When not in use, the best way to store your climbing rope is to flake it into a rope bag. Flaking means starting at one end of the rope and letting the rest of the rope follow, without coiling or looping.

Start with tying a figure 8 stopper knot at one end of the rope, with about a foot of tail past the knot. Inside the bag, pass the tail through the eyelet at the bottom of the bag and tie another figure 8 stopper outside the bag. This will keep the tail from being pulled into the bag, and the rest of the rope from being pulled out the bottom of the bag. Also you cannot rappel off the end of your rope with this set up.

After tying the two knots, the rest of the rope can be "stuffed" into the bag, one bit at a time. It is important not to stuff coils or loops of rope as this may cause the rope to tangle and possibly knot itself. These tangles can only make it more difficult to smoothly feed the rope out later.

Another benefit of flaking the rope like this, is that every bit of the rope will pass through your hands as it is flaked. This allows you to look and feel for any damage to the rope.

Here are a few things to keep in mind when storing your rope:

- Keep your rope in a rope bag when not in use and keep it stored in a safe place. Ropes tend to "snake away."
- Properly flaking your rope into the bag ensures that it will be ready to go the next time you need it.
- Store ropes used for climbing away from cutting edges, sharp tools, corrosives, chemicals, or heat, sunlight, and humid conditions.
- Rope bags are made to hold lengths of 100', 200', and 300', etc. The proper length for a rope depends on its intended use. We generally use rope cut at 100' or 200'.

SUMMARY

- Climbing rope shall be UIAA approved. (Union Internationale Des Assocotions d'Alpineisine / International Organization of Alpine Clubs).
- Only use static line approved for bank scaling. Use Kernmantle rope.
- Dynamic ropes are mainly used for recreational climbing. These ropes have about a 10% elongation at the time of impact.
- Always inspect rope before a climb and after a climb.
- Never splice a climbing rope.
- Never use your climbing rope as a haul rope.
- A retired rope may be used for a haul rope, but should be easily identified as such.
- When a rope is retired it should be cut into smaller pieces so it will not be used for climbing.
- Do not allow someone to get a hold of a retired rope and use it for climbing.
- Avoid stepping on your rope.
- Clean your rope when it becomes dusty, muddy, or dirty.
- You may wash the rope in a washing machine using a very mild detergent, such as ivory soap.
- Do not put your rope in the dryer to dry. This will damage the rope unnoticeably.
- Hang your rope to air dry, but not in direct sunlight.
- As a rule one should retire the rope after a severe impact fall. The sheath on the outside of the rope tends to hide the internal damage. The risk is too much to chance.
- Standard lengths of rope should be 100 or 200 feet. Recreational climbing rope may be different.
- Keep your rope in a rope bag when not in use. Store it in a safe place.
- Keep rope away from heat, chemicals, sunlight, and humid conditions.
- A rope tends to disappear when left exposed.
- Rope bags usually come sized for 100', 200', or 300' of rope.
- Do not lend your rope to anyone except those you trust to take good care of it.
- **Remember that your life depends on the integrity of the rope.**

Caltrans Bank Scaling and Rock Climbing Training

Chapter 7

Knots and Hitches

KNOTS

Knots connect climbers to the rope and to the anchors. They enable us to make webbing and cordage into slings. They can secure ropes together, and provide a variety of functions in the climbing world, including, but not limited to; anchoring, lowering, belaying, self-rescue, and providing a place to hang our lunch.

We use "knot" as a general term; referring to all knots, hitches, and bends. The free end of the rope is the end you use to tie the knot, while the standing end refers to the rest of the rope.

- We use knots to form a loop called a "bight", fastens two ends of the same cord, or creates a "stopper" in the end of the rope.
- A bend joins two free ends together, and a hitch grips a shaft or another rope.
- A finished knot should be neatly "dressed" with no extraneous twists to facilitate easy visual inspections. Knots should also be cinched tightly for security.
- Rope, cordage and webbing are strongest when loaded in a straight line. When you bend the rope or web to create a knot, the strength of the rope is reduced.

FOUR MAJOR CONSIDERATIONS FOR KNOTS

The four major considerations for knots are:

1. Ease with which knot is tied.
2. Ease with which knot is identified.
3. Ease with which knot is untied.
4. Strength loss to line.

KNOT BREAKING STRENGTH

Remember that strength alone is not the only consideration. The Overhand loop is a strong knot, but may be impossible to untie after being loaded. The other loops are within a few percent, but much easier to untie.

Neatness counts when tying a knot. Making the rope run smoothly without any extra bends or twists is called dressing the knot. It makes the knot stronger, and easier to check.

KNOT SECURITY

A secure knot is one that does not come undone by tumbling or slipping. The figure 8 series of knots and the double fisherman tend to tighten no matter how they are loaded. Bowlines are not particularly secure, as they tend to loosen when the knot is loaded and unloaded or may tumble if pulled in the wrong direction.

The water knot can be secure but it must be set tight. Safety knots can be set on each side, but should not be relied upon entirely. Before climbing, always check the security of a previously tied water knot.

UNTYING KNOTS

To untie a knot, you need to create movement to generate slack somewhere in the knot that will allow more movement. Try pushing parallel ropes opposite directions, or bending a loop further. Sometimes twisting or rolling the knot between your hands will help.

People that work with rope a lot carry a fid or a marlinespike, each type a strong, slender tool that can be inserted into the knot to help loosen it.

In an emergency, if you cannot untie a knot, you should be equipped to safely cut the rope.

KNOT BREAKING STRENGTH

The tests used Federal Test Method 191A, 6016 since it is the method used by the manufacturer's to determine new rope strength. Four sets of five breaks were done to determine the strength of the rope and web without a knot. Five breaks were done for each knot and the average results reported. The knots were tied and Jerry Smith, California Mountain Company, Ltd. conducted the tests.

Control Rope	10,705	**Strength in Pounds**	**Percentage Lost**
Control Web	4,800		
BENDS			
Double Fisherman's Knot		8,440	21%
Figure 8 Bend (Flemish Bend)		8,640	19%
LOOPS			
Figure 8 Loop (with a bight)		8,560	20%
Figure 8 Loop (follow-through)		8,640	19%
Double Figure 8 Loop		8,820	18%
Inline Figure 8 Loop		8,000	25%
Bowline		7,180	33%
Overhand Loop (with a bight)		9,060	15%
Overhand Double Loop		7,900	26%
ROPE WITH A LOOP (a)			
Figure 8 Loop		6,960	35%
Inline Figure 8 Loop		6,280	41%
KNOTS IN WEBB			
Water Knot		3,060	36%
Overhand Loops		3,120	35%
Figure 8 Loop (with a bight)		3,360	30%
Figure 8 Loop (follow through)		3,560	26%
Water knot single loop		5,700	
Water knot double loop		12,920	
Water knot triple loop		22,860	

Caltrans Knots for Bank Scaling

We have grouped the knots according to what they do to help you picture which knots go where. You will notice that the knots group into a few families, which makes tying them easier to remember. We use the Figure 8 Family of knots in our climbing operations. Figure 8 knots meet all four considerations of the best rescue knot. In webbing, we use the Overhand family of knots.

Figure 8 Stopper

Father of the Figure 8 family. This knot allows retention of 80% of the rated strength of the line they tie into.

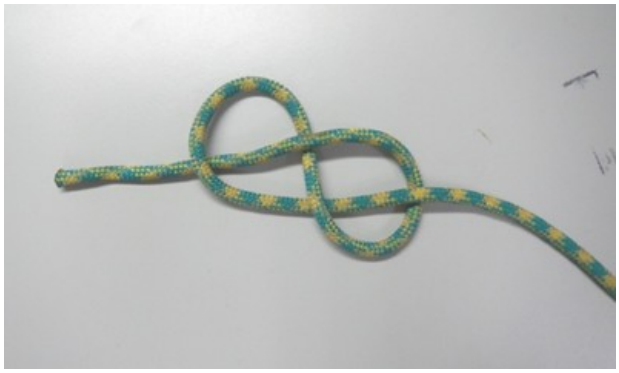


Figure 8 Bend (Flemish Bend)

Used to join two lines of approximately equal diameter together: If the two ends are the ends of the same piece of rope, this forms a loop.

Note:
The tail of the Figure 8 Bend or the Figure 8 Follow-through should be between one and two fists long.

Figure 8 Follow-through

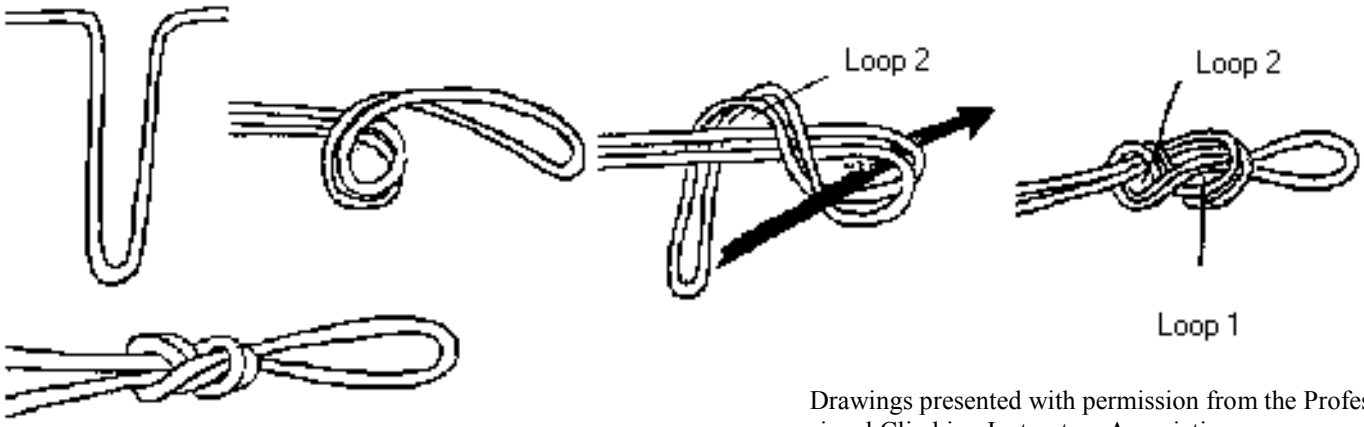
The Figure 8 follow-through is the knot we use to secure a line around a fixed anchor point. It is also used to tie in a climber on belay.

Figure 8 on a Bight

This is a common way to tie into the middle of a rope. Loading the rope from below weakens this knot.

Follow these steps to tie a Figure 8 on a bight:

1. **Form about a three-foot long bight at the point in the rope where you want to tie in.**
2. **Treat the rope as a single strand as you make a pretzel in the rope the same way you form the first half of a figure 8 follow-through knot.**
3. **Dress and set the knot.**



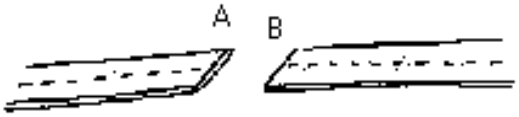
Drawings presented with permission from the Professional Climbing Instructors Association

Water Knot

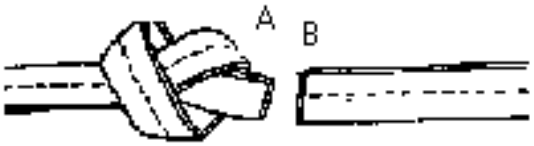
We use a Water Knot for joining nylon webbing only…this knot is not strong enough to use for rope. Make sure that you leave at least 3" of webbing extending from either side of the knot. These tails may be taped down with sticky tape.

To tie a Water knot:

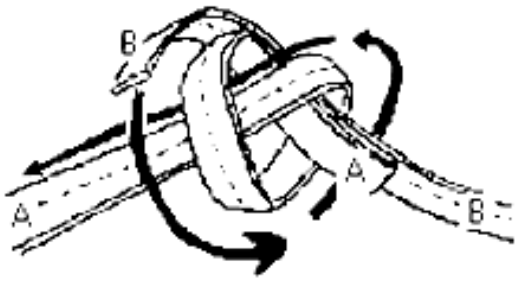
First, place two ends of webbing as shown.



Next, tie one of the ends in a loose overhand knot.



Then, take the free webbing end back through the overhand knot.



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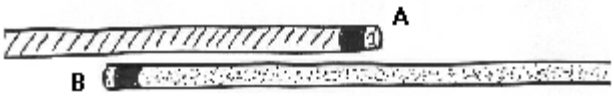
Double Fisherman's Knot

The double fisherman's knot is used for joining two ropes together, but it can be difficult to untie once loaded. Be sure that there is at least 4 inches of each rope extends from the knot after it is tied and tightened to allow for slippage.

To tie a Double Fisherman's knot:

Place the ends of rope to be joined together as shown.



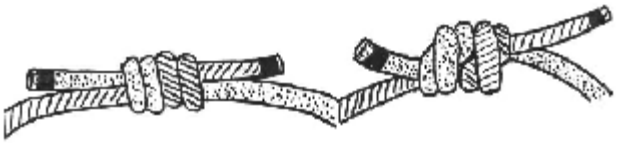
Wrap one end of the rope clockwise twice around the other rope and itself and work the rope so that the loops run back toward the main rope, wrapping them back on themselves.

Pull the rope running end of the rope through the rope you just created.

Repeat these steps with the other rope.

Pull the ends to set then pull the two sliding knots together and dress them.

The finished knot should look like this.



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Girth Hitch

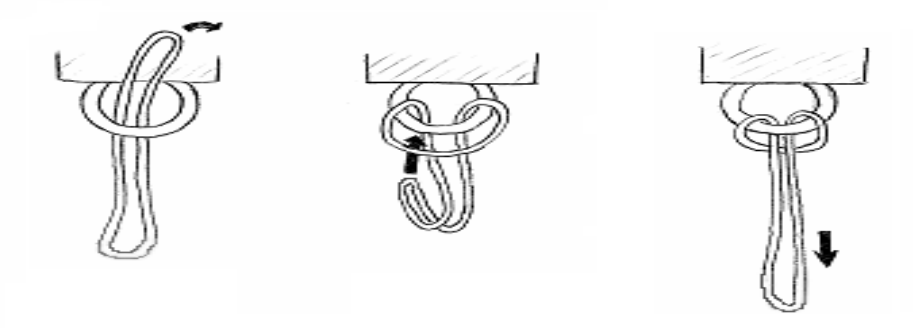
The girth hitch, also known as the cow hitch and the lark's head, can be used for many purposes. It can be used for joining two slings together. It is one of the simplest hitches to tie.

To tie a Girth Hitch:

Pull a bight of rope or webbing around the object.

Bring the standing end of the rope or webbing through the same bight.

Pull on the standing end to secure the knot..



A girth hitch tied onto a ring.

A webbing girth hitch tied onto a cord sling.

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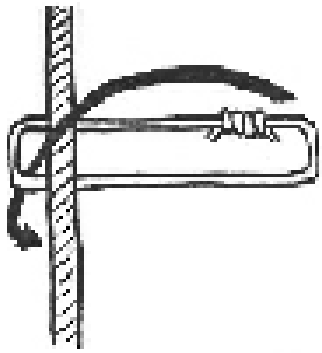
Prusik Knot

We use the Prusik Knot to tie one rope onto another so that the knot holds when loaded, but still slides easily when loose.

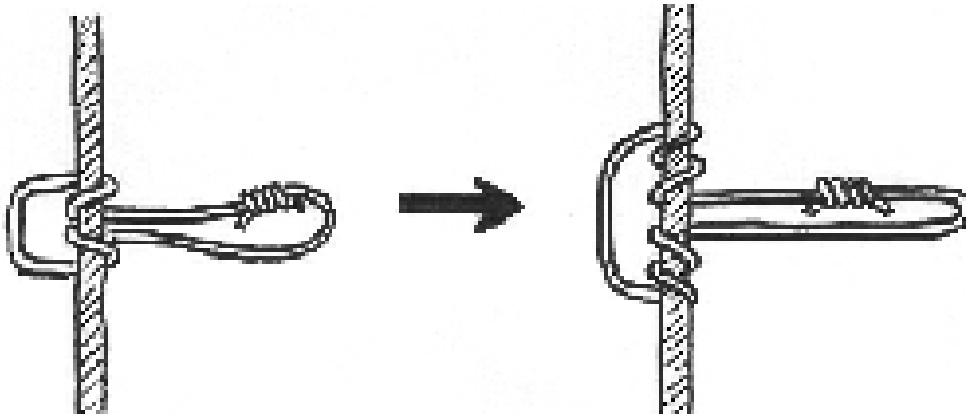
To tie a Prusik knot:

1. Tie a double fisherman's knot in a three to five foot loop of cord.



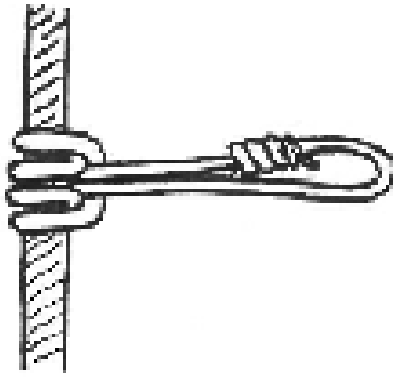
2. Place the loop either beside or underneath the main rope.

3. Pull the end of the rope with the double fisherman's knot up over the main rope and down through the prusik cord.

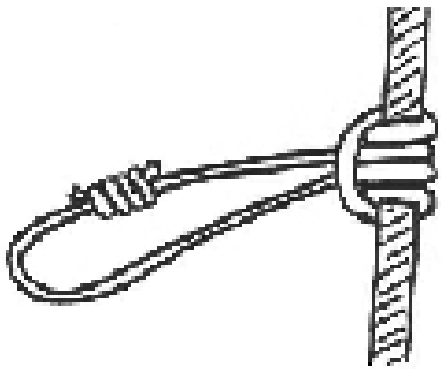


4. Repeat Step 3.

5. Pull on the long end of the rope to set the knot.



6. Dress the knot so it looks like the one below.



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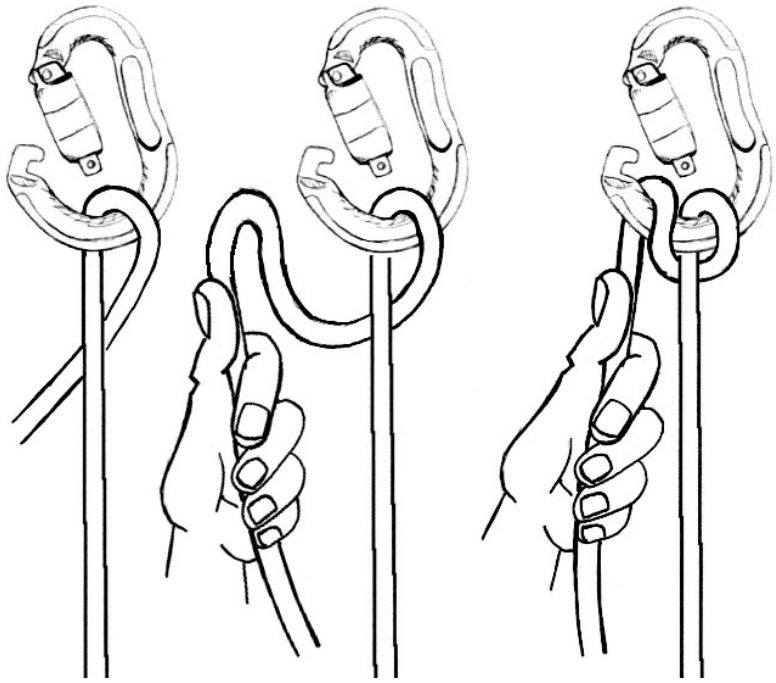
Munter hitch Illustration

The best friction knot, better friction then any belay device but has tendency to create kinks in the rope. An excellent method for belaying and lowering. The munter is reversible. Make sure the load is on the spine side of D shape carabiner.

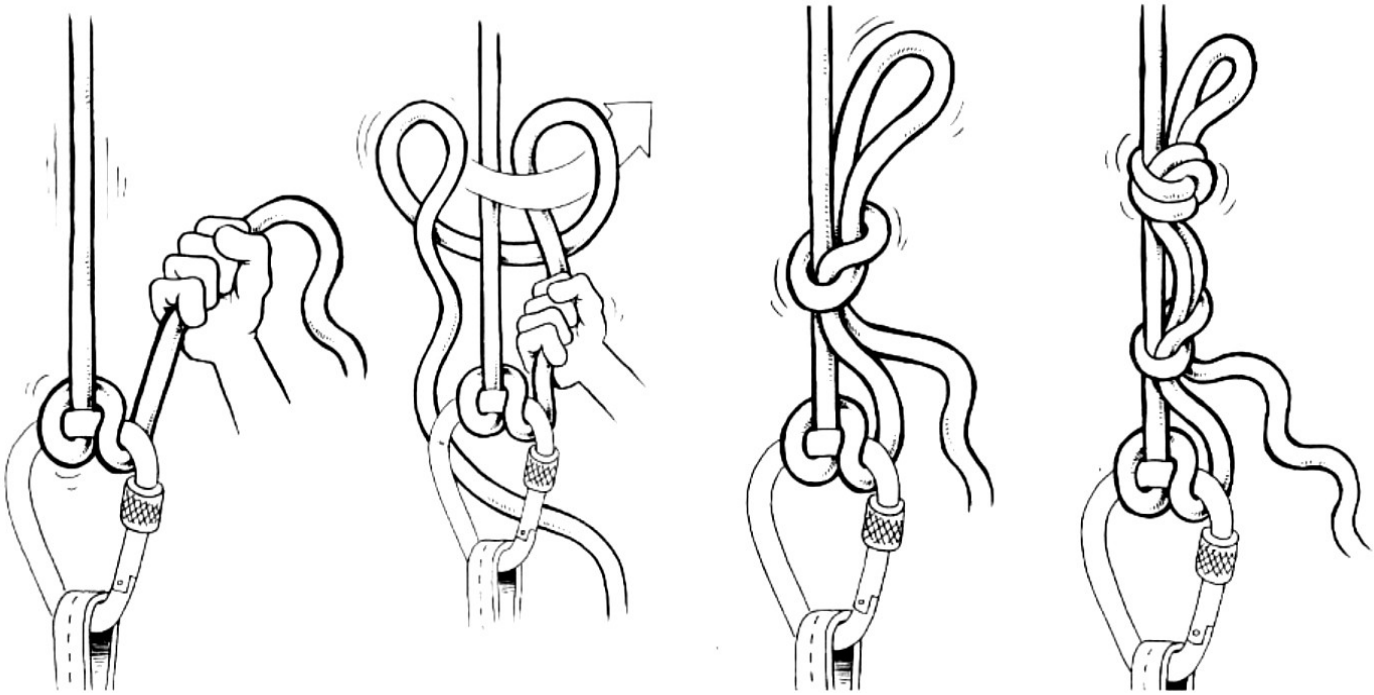


Illustrations by Geotech North
San Luis Obispo.

Twist a coil on the rope, then fold the lower strand over the upper strand, clip it into a carabiner. Can easily be transformed into a clove hitch.

In rescue situation the Munter hitch combine with the blocking knot will keep the system releasable.

Munter Mule Illustration



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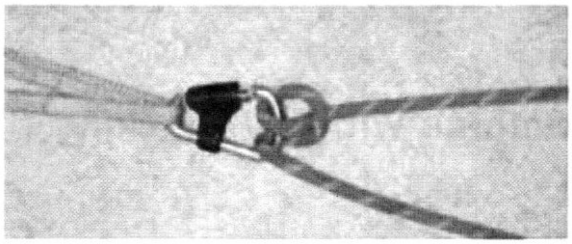
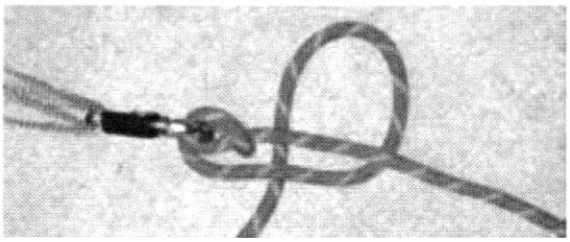
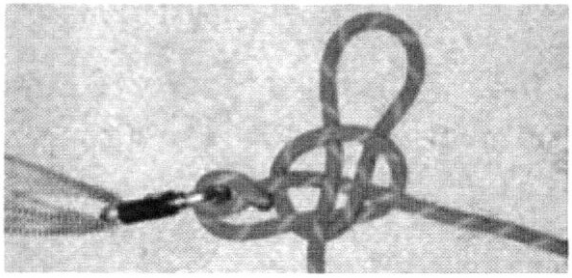
Tting off a Munter on a belay line with a Mule Knot



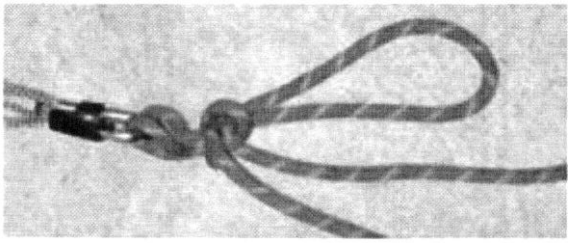
Step 1: Hold the load on the Munter Hitch tightly during the entire process and do not lret go of the braking hand even fo an instant.



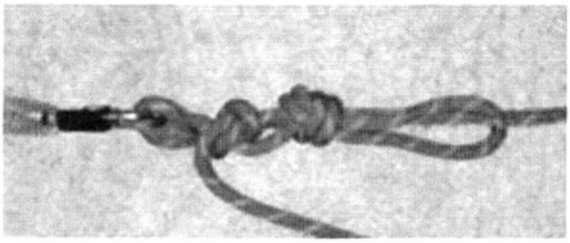
Step 2: Make a loop of rope as shown.



Step 3: Pass a bight of rope through this loop as shown creating an overhand slip knot.



Step 4: While ensuring that the load will not suddenly drop tighten the overhand slip knot .



Step 5: With the bight of the rope exiting your slip knot above, tie an overhand knot around the loaded linent the Munter tied off. We call this the Munter Mule.

SUMMARY OF KNOTS

Figure 8 knot	The number one knot in climbing.
Figure 8 follow through	Used to tie into your harness and into anchors systems.
Figure 8 Bend	Used to connect the ends of two ropes together.
Figure 8 on a bight	Used to tie off to an anchor. Or hang your lunch from.
Water knot	Used for tying the ends of webbing together.
Double Fisherman's knot	Used for making up a cordelette.
Basket Hitch	Used for a quick anchor or directional.
Girth Hitch	Used to wrap and hold onto an object.
Munter-Mule combination	Used for lowering or belaying. A Mule ties off a munter.
Prusik	A rope on rope friction hitch.

Knots generally weaken the rope where they are located in the system. There have been many tests done to show this, but the actual strength loss numbers vary widely. The summary shown here indicates a range of relative strengths with some common knots tied in the system.

KNOT STRENGTH Summary

Knot	Relative Strength
No knot	100%
Figure Eight	70-75%
Double Fisherman	65-70%
Water Knot	60-70%
Overhand Knot	60-65%

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Chapter 8

Anchor Systems

Anchor Building

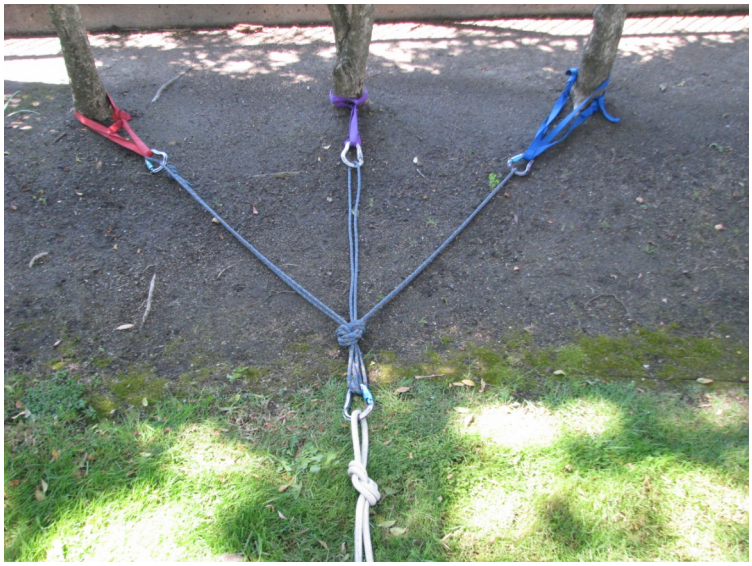
The goal of anchor building is to establish proper protection for the climber and a clear understanding of situation in which it will be used. It is important to know what we you are asking of the anchor and understand the limitations with the anchor design. The anchor must be sufficient to provide adequate strength for the anticipated climbing related activity and must take into consideration site variables and situations which could occur when it is being used.

In the beginning class, the focus is centered around establishing the basic concepts of single point anchorage utilizing adequately sized objects such as large trees, large rocks and vehicles. By the end of the beginning class, the student is expected to have a working understanding of utilizing webbing and static climbing rope to create a single point anchor sufficient to be safely utilized for a Caltrans climbing operation. This working understanding is accomplished by providing instructor lead demonstrations and multiple training exercises over the first two days of instruction.

In the refresher training course, anchor building techniques developed in the beginning class are reviewed and practiced. Additional demonstrations and instructor lead exercises are then provided to expand the student understanding of anchorage systems and application to varying site conditions. This additional training is intended to expand the students understanding of anchoring by introducing two point anchorage systems, multiple point anchorage systems and the concepts of anchor equalization. By the end of the refresher training, the student is expected to have the ability to develop a single point and multiple point anchorage system which could be safely utilized in a Caltrans climbing operation.

During each training session, the importance of proper site stewardship is discussed and practiced. For instance, it is important for the students to be able to indentify potential impacts to the climbing site. This includes understanding how ropes could cause long term damage to trees and shrubs, how visual impacts can be minimized by conscientious during site access, and minimizing long term impacts by developing thoughtful permanent anchorage systems

Single point anchorage systems



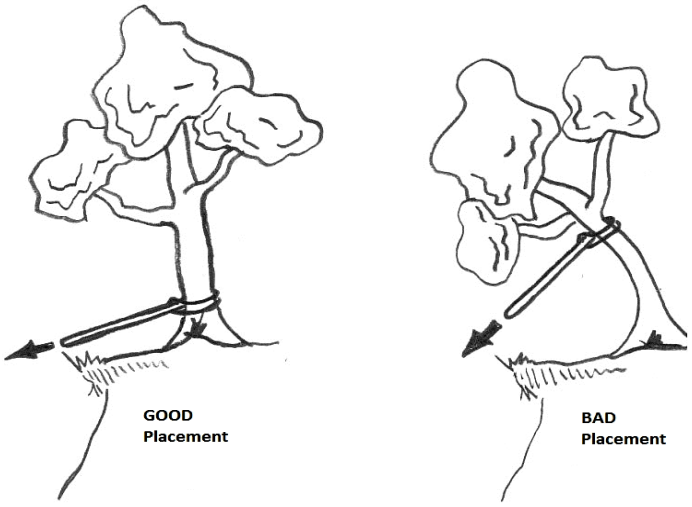
Multiple point anchorage systems

Anchor Systems

Recreational climbers have the luxury of climbing where they want to; usually well established routes with good, well known anchor points above. The climber can set her artificial protection at the anchor location, drop a rope and go on to climb safely, knowing she is tied into a solid anchor above. Caltrans bank scalers do not have that luxury. They often must access slopes where no recreational climber would even consider climbing. Think about it. The purpose of scaling is to remove loose rocks. A recreational climber likes rocks that they can grab onto and hang from. Caltrans scalers must often improvise an anchor out of the natural surroundings.

An anchor is the starting point of a system that will support the climber and anything he might need to carry. It is important to consider this when selecting the anchor. A large tree with a rope tied around it can be a solid anchor. Two of the more common anchors that we use in bank scaling are a Friction Wrap and a Figure-8 Follow Through, tied around a large tree or other solid object. Care must be taken when selecting a single-point anchor. A tree should be healthy with a good root system. Rocks should not be able to shift or roll. Observe if the rock is <u>on</u> the ground or <u>in</u> the ground.

We like to use webbing for tying anchor points around rocks. It has high abrasion resistance and its wide surface area provides a good grip on the rock. . However, if a long extension is needed from the anchor to where you want to attach the system, use a rope, rather than lengths of webbing or smaller lines tied together.



Keeping the rope or webbing as close to the base of the anchor as possible maximizes the strength of the anchor. If there is a possibility of the web sliding up or off the anchor point, a Girth Hitch or a Clove Hitch will make the web grip the anchor point.

Illustration by Geotech North San Luis Obispo

Sometimes it is necessary to combine two smaller anchors to create a stronger anchor. When two anchor points are connected together at a single Master Point, an angle is created. If you do not use a long enough piece of web, the resulting interior angles will be large. As the angle increases, the force on the web (but not the anchor point) will increase. At high angles, the force can be as much as twice the weight of the load.

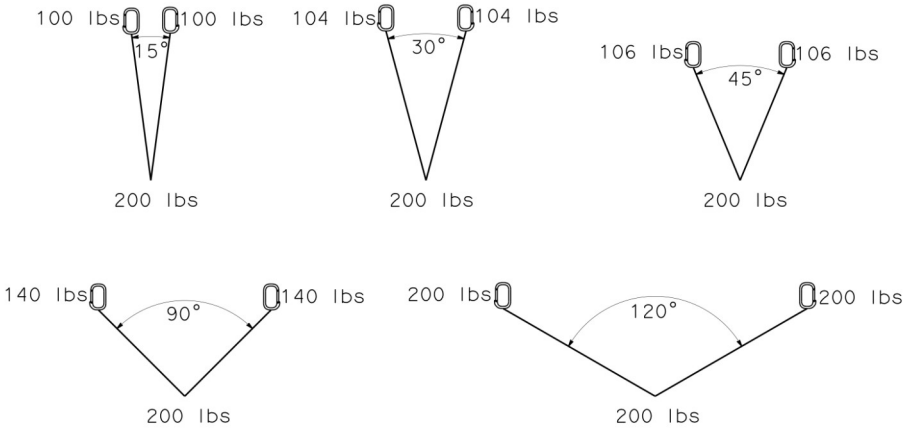
An anchor point may be strong when pulled one way, but much weaker when pulled in a different direction. Check the direction and make sure the anchor point will withstand the load.

Here are a few things to think about when building an anchor:

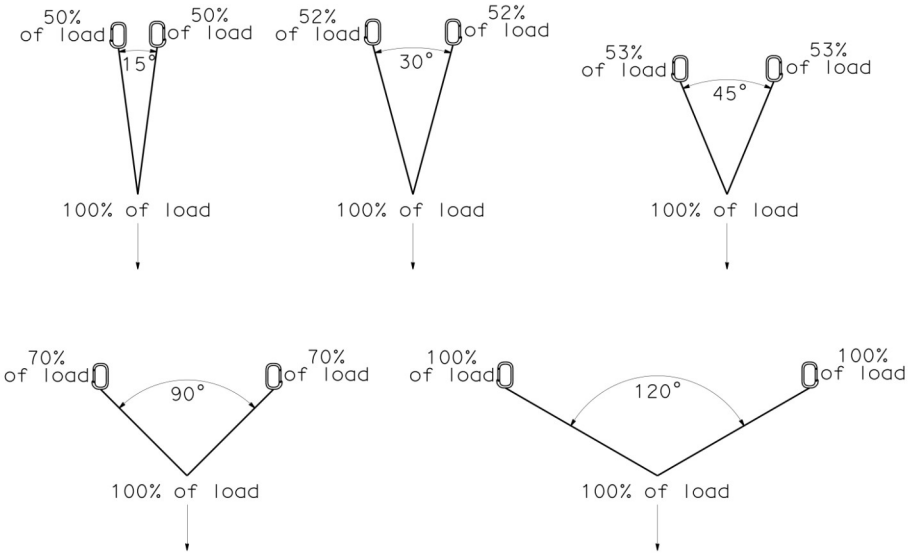
- Choose an anchor system that is competent and easy to get to.
- Inspect the anchor tie and have someone else inspect it also.
- Tie your anchor knots neatly and tightly.
- Have a backup system built into your anchor point.
- Pre-load your anchor rope or webbing in the direction of pull.
- To connect a rope to a Master Point, use two opposite and opposing carabiners or locking carabiners.

It is important to understand how different angles effect the loading of each element of the anchor system and directionals used. The larger the angle at the master point or the directional, the greater the load that each element will receive. (Calculations by Geotechnical Services Branch D)

Angles and Loads

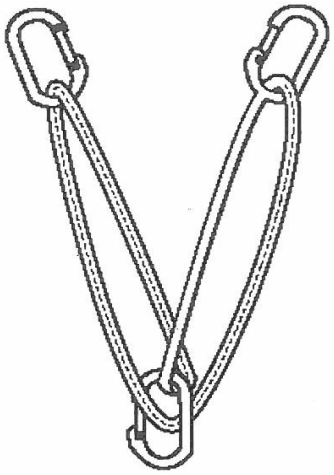


Loads on Individual Pieces Connected at Varying Angles



Loads on Individual Anchors Connected at Varying Angles

Anchor Equalization

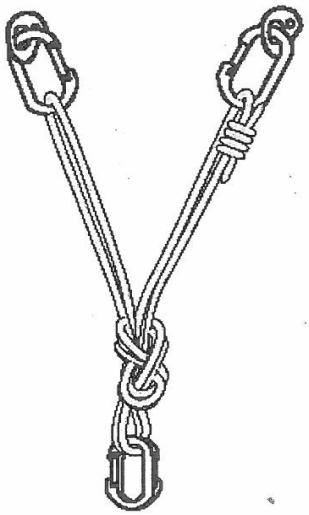


Pros
- equalized for changing directions of pull
- typically constructed with a normal length runner

Cons
- failure of one piece adds shock load to remaining pieces
- if sling fails, complete anchor failure occurs

Self Equalization

Pre - Equalization



Pros
- built in redundancy
- easy to use centralized clip in point
- no additional shock loading if one piece fails

Cons
- equalized for one direction of pull only
- ususally requires extra long sling

Drawings presented with permission from the Professional Climbing Instructors Association

System to evaluate anchors—PESSBEE

P– Protection—Goal is perfect pieces

E– Equalization– Are the forces well distributed between anchors

S– Stability-Is the master point Stable

S-Strength-Is the anchor point strong enough

B-Belay-Can the belayer do a good job of managing the belay

E– Edges– Are the edges properly protected

E-Efficiency-Is the efficiently use available resources

PITONS

Pitons are forms of passive protection that can be used for anchors or as directional's. Pitons are placed in cracks in rock by pounding them in with a hammer. Pitons come in a variety of shapes, sizes and lengths. The size and shape of the crack determines the correct size and shape of the piton that should be chosen. When properly placed, a ringing sound as opposed to a thud resonates with each hammer blow. A webbing loop should be placed through the holes in the pitons and the carabiner attached to the webbing. Remember to avoid metal to metal connections whenever possible. .

Thick Blade Various Sizes Cost $10.00

WIRE STOPPERS, NUTS & FRIENDS

Like pitons, nuts and wire stoppers are forms of passive protection, whereas cam locks (also called friends) are active protection. Friends are mechanical devices that exert outward pressure on the inside walls of a crack locking themselves in place. Nuts and wire stoppers are placed in cracks and are held in place by the load applied to them. All of these devices can be used for anchors or directional's. Beware that when the direction of the load changes or during episodes of loading and unloading. nuts and wire stoppers can become loose and fall out.

Fall Tech Anchors

This Page is Under development

Sample Anchor Systems

Vehicle Anchor

Guardrail Anchor

Picket Anchors

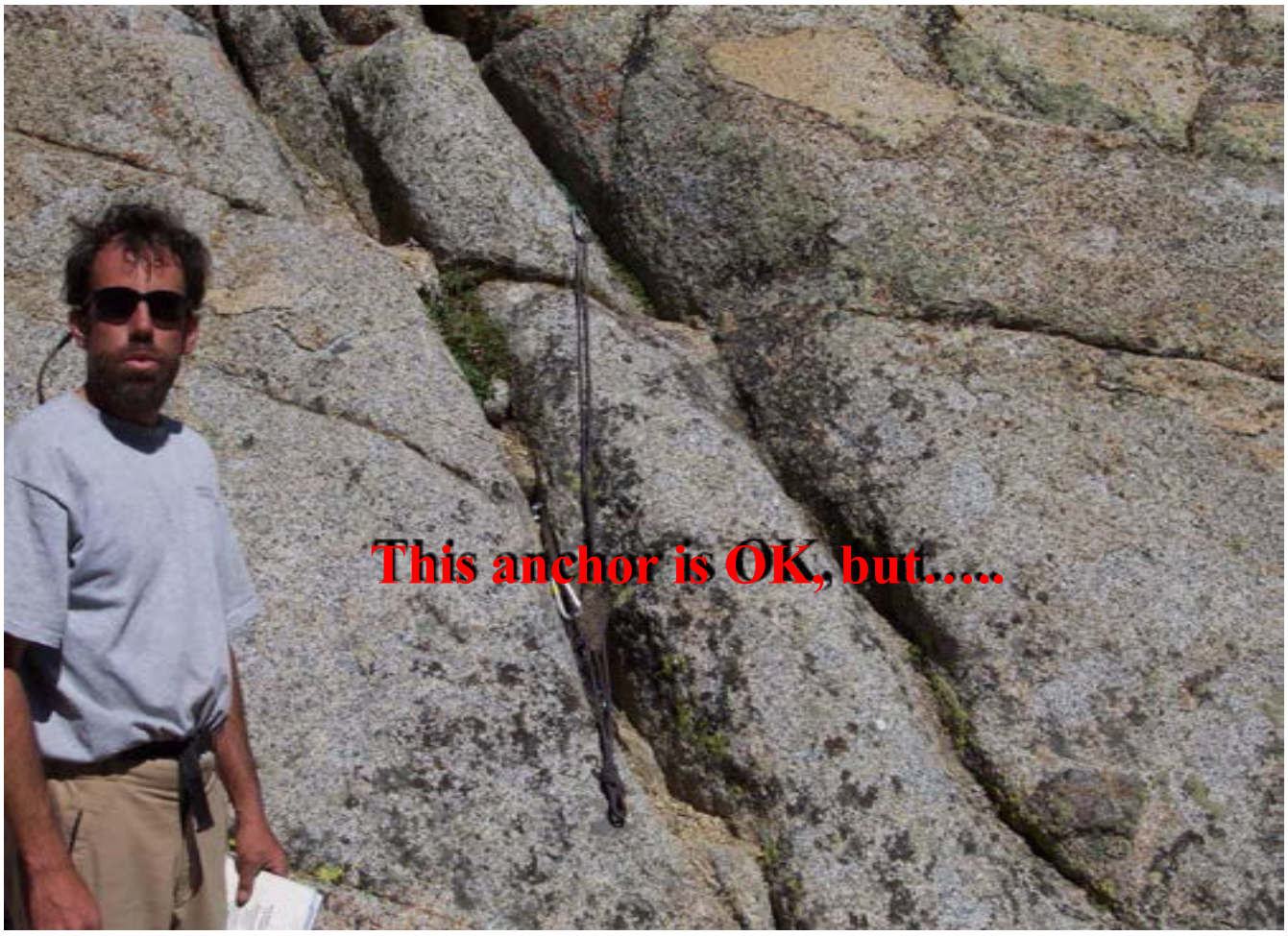
This Page is Under development

Manta Ray Anchors

This Page is Under development

SUMMARY ANCHOR SYSTEMS

- **Pick an anchor system that is competent and easy to get to**
- **Inspect the anchor tie and have someone else inspect it also**
- **Tie your anchor knots neatly and tightly**
- **Pre-load your anchor rope or webbing in the direction of pull. Is the anchor equalized?**
- **Use two opposite and opposing carabiners or locking carabiners at the master point**
- **Ensure that you have adequate edge protection**
- **Have you adequately protected the trees and minimized impact to the environment**



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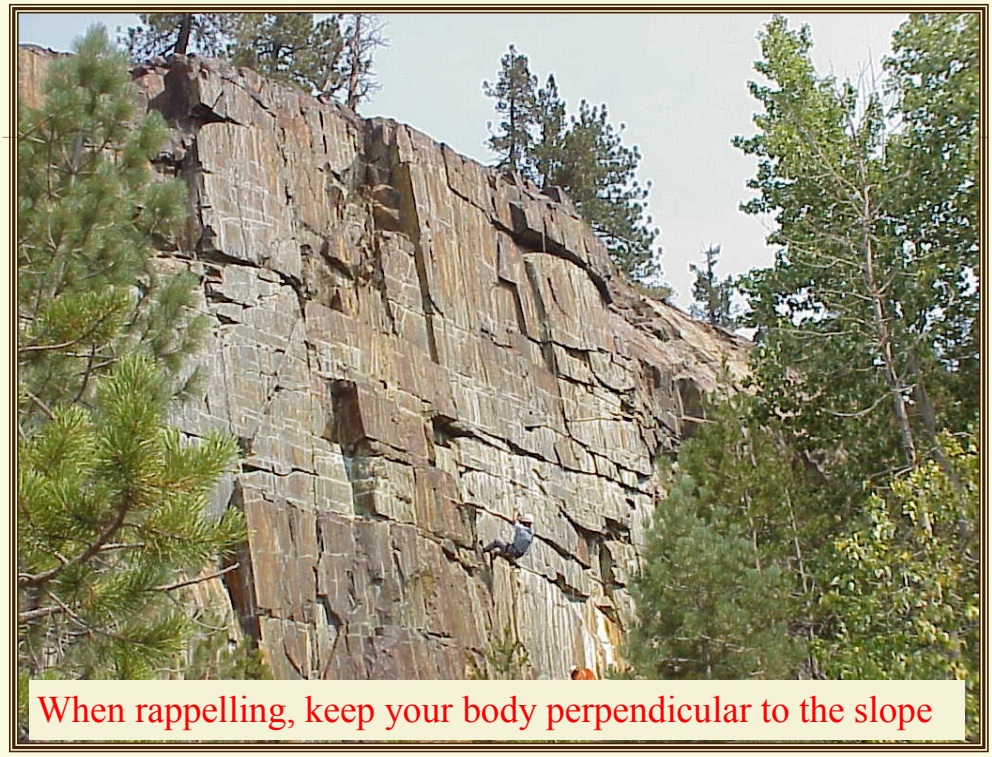
Chapter 9

Working on Rope



When rappelling, keep your body perpendicular to the slope

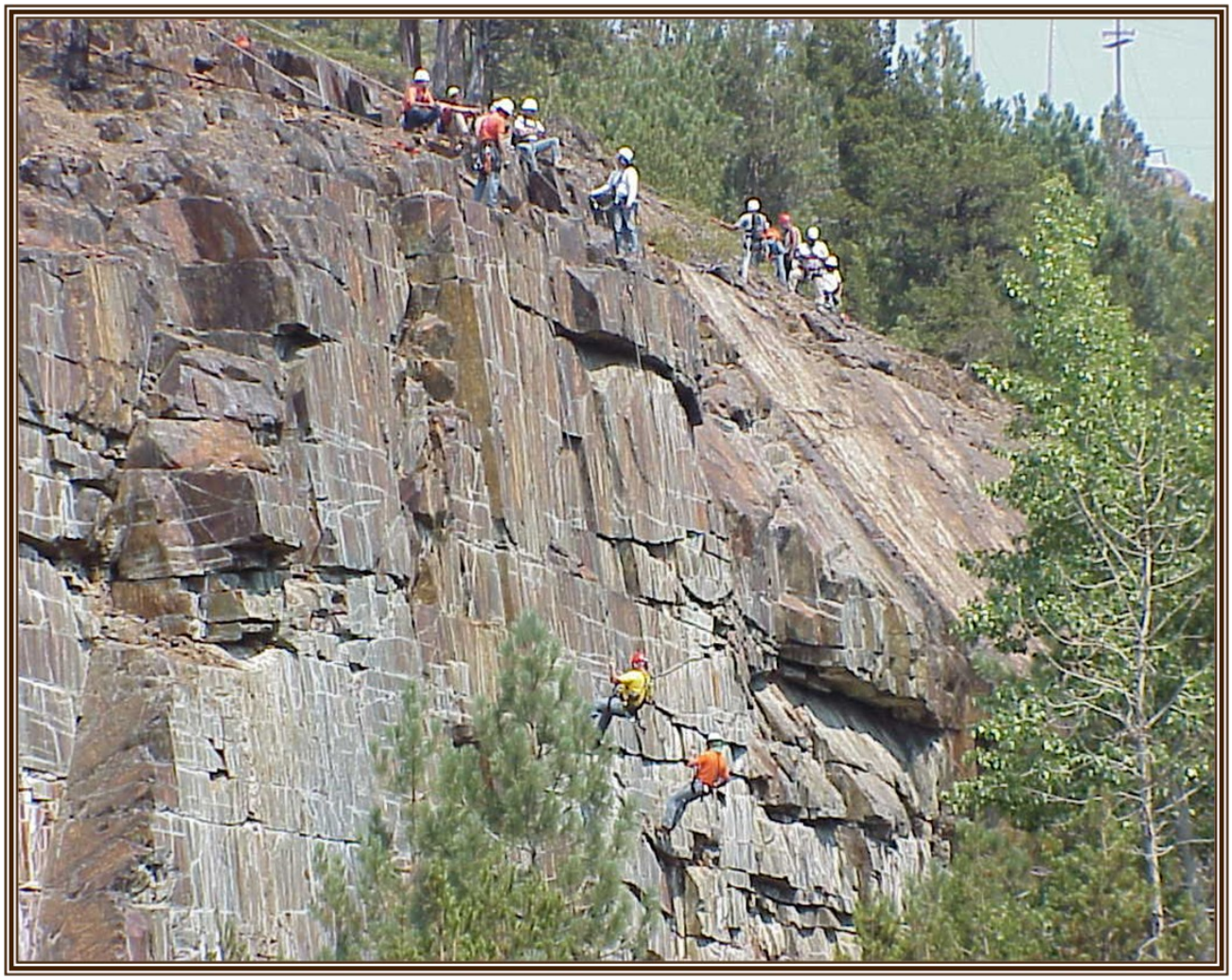
WORKING ON ROPE

Rope work for bank scaling includes:

- Rappelling
- Ascending
- Lowering
- Belaying.

In this manual, workers on rope are referred to as “climbers.”

- All climbers should be tied in when within a minimum of 6 feet of the edge of the slope.
- When climbers are below them, belayers should have visual contact with the climbers and care should be taken to prevent rocks from falling onto the climbers below.
- The rope used for descending or ascending shall be securely anchored above, and have a figure-8 knot tied near the tail.



RAPPELLING

Most areas that require bank scaling are too steep to access safely without the help of a rope. With a rope anchored to a point above the slope, the climber can lower himself down a slope by rappelling. Rappelling, also known as abseiling, is a controlled decent using a rope. Proper rappelling technique is one of the main focuses of the entry-level Beginner class. The techniques taught involve using a Rescue 8 descender to introduce enough friction on the rope, so that the climber can control his descent with one hand. Once they have rappelled to a scaling location, climbers must be able to "lock off" the 8, so they can be free to work with both hands.

Rappelling is a technique used in both recreational and professional applications that require rope access. Recreational climbers might rappel down to the base of their climb; or cavers might rappel down to access an underground cavern. Another adventurer may rappel with a kayak on their back to the entry point of a white-water run. Industrially, rappelling might be used outside tall buildings to perform maintenance or wash windows; or by a rescuer to access an accident site. Military special forces may be trained to rappel from an airborne vehicle.

While all these applications fall under the broad category of rappelling, it is important to note that not all rappelling is the same. Someone trained to rappel down the side of a building to wash windows is not necessarily qualified to jump out of a helicopter. Similarly, someone trained only to use tree-climbing techniques would need additional training to learn the techniques used in bank scaling.

There are skills required in bank scaling that may not be included in other rope access disciplines. These skills include the ability to:

- Move side to side, perhaps to get a rock that is not directly below their anchor
- Move quickly out of the way of a falling rock dislodged from above
- Carry an entire days worth of tools and food up and down the slope
- Stay motionless on the slope, while live traffic runs below them

IMPORTANT!!

While rappelling, all persons shall maintain at least two points of contact with an anchored rope at all times, as noted below:

1. **The primary point of contact shall be a tended or locked off rappel device, such as a Rescue-8.**
2. **The second point of contact shall be an approved belay. If a self-belay is established, this may serve as the second point of contact and the belay omitted.**

RAPPEL SET UP

To rig a Rescue 8 for descending, a bight of rope is brought through the large opening of the device, then around the small end of the device, and finally pulled tightly against the device. The Rescue 8 is then attached to the climber's harness using a locking carabiner. The tail of the rope will be used to control the descent, so it should be on the side of the climbers strong hand. While scaling, the climber should keep the tail of the rope in its bag, attached to the climbers body; either clipped to the harness, or worn as a back pack. It is important not the have the tail hanging below the climber, since the climber will be knocking rocks below him.

Beginning climbers tend to hold the control line in front of them, near the Rescue 8. However, this is not only a weaker position for the climber's arm, it unfavorably allows the possibility that a glove, or even the hand, could ride into the device and jam it. Greater control can be gained by grasping the rope further away from the Rescue 8 and keeping the hand near or behind the hip.

A single "wrap" of the Rescue 8 can provide the friction necessary for a controlled descent of a single climber. However, there will be time when the climber will need to carry an extra-heavy load. There is a simple way to increase the amount of friction for even greater control. Bringing the bight through the opening a second time for a "double wrap" creates even more friction for greater control of heavier loads.

Single Wrap with Self-Belay

Double Wrap with Self-Belay

SELF-BELAY

A belay refers to a system that is used to arrest the fall of a climber. Typically a belay is a second rope that is independent of the climbing rope. The belay line is attached to the climber with a "hard" connection. The belay line is tended by a belayer. In case the climber were to lose control of his descent, the belayer could apply friction to the belay line, thereby arresting the climber's fall.

DESCENDER JAMS

What causes jams when rappelling?

- Gear, clothing, gloves and even fingers can be sucked into the descender.

- Fast rappels sometimes generate slack in the rope below the descender, usually after negotiating some sort of overhang. Such slack can cause the rope to slide up the sides of a figure eight descender and form a knot called a girth-hitch on the top of the descender. The girth-hitch knot secures under body weight and when stuck, no one-arm pull-up is going to get you out of this mess.

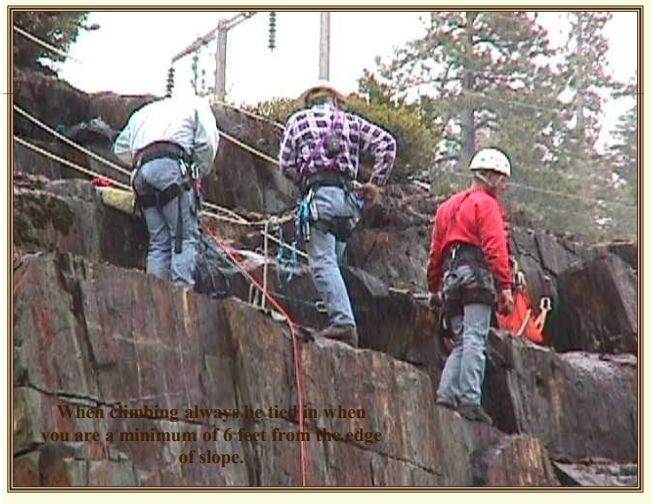
Nevertheless, sloppy rappelling form is the main cause for descender jams.

PREVENTION

Prevention goes a long way toward keeping you alive in rappelling.

- Using a Rescue eight reduces the chance of a girth-hitch lock-off.

- One way to keep a loop of rope from pulling over the sides of your figure eight descender is to pull the initial loop down through the large hole in the "eight" when it is rigged onto the rope. This keeps the vulnerable loop of rope on your side of the descender, away from the wall.



ASCENDING

During or after a scaling operation, it is sometimes necessary to ascend up the rope. Ascending a steep slope can be difficult, and it is important to use the advantages that your climbing gear provides. Ascenders have a cam which, when engaged, allows free movement on a rope in only one direction. If the ascender is pulled downward, the cam will close onto the rope, preventing downward movement.

Ascenders are used in pairs so that weight can be placed on one while the other one is moved up. On a slope, when you have reasonable footing, ascenders on the rope can provide stability. The climber can step forward/upward, moving one ascender up the rope as he steps. Upward progress is made as the climber alternates moving one ascender up, then the other. Training and practice are key to learning how to do this correctly and efficiently.

SWITCHING FROM RAPPEL TO ASCENT

The exit route from a scaling location may not always be the rappel to the bottom of the slope. When it is quicker or more convenient to return to the top of the slope, the climber must be able to safely switch from a rappel to an ascent. In class, we emphasize making this switch while maintaining a minimum of two points of contact to the climbing rope. While rappelling, the two points of contact are usually the tended rappel device and an ascender as a self belay. When setting a third point of contact, remember to tied off the rappel device to be able to work with both hands. The third point of contact could be as simple as setting a second ascender on the climbing rope. A third point of contact could also be a prusik hitch connecting the climbing rope to the climber's harness at a secure location.

PRUSIK

Friction knots offer a similar functionality to an ascender. Remember: friction creates heat and heat can damage ropes.

CHICKEN FOOTING

Chicken-footing is a technique used to ascend a rope in a near-vertical or free-hanging situation. Ascenders are made to hold in your hands, and even the strongest of people would find it nearly impossible to ascend a rope using only their arms. To effectively make an ascent, the climber needs to involve the strength of their legs. There are a couple of useful pieces of gear that can be applied here: the cord sling and the webbing sling. Using a carabiner, attach the cord sling to the lower ascender. The webbing sling can then be girth hitched to the cord sling. The combination of the two lengths of slings gives the climber a step for support to ascend.

IMPORTANT!!

When ascending, just like rappelling, the climber shall maintain at least two points of contact with the rope at all times

1. **This applies even while changing from a rappel set up to an ascent set up.**
2. **Each ascender counts as a single point of contact.**
3. **A prusik on the climbing rope may be a point of contact.**

BELAYING

A belay is a system set up to prevent a climber from falling, should he lose control during a climb. In a typical rappel situation with belay, a climber will rely primarily on their own climbing rope, and a second rope will serve as a belay line.

The belayer has two duties. The first is to feed or retract rope through the belay, so that a climber on belay has the freedom to move around without restriction. The second duty is to quickly stop the descent of the climber in case of a fall. To do both of these, the belay must always be in communication with the climber. In fact, there are some special terms that have been developed in the climbing community to quickly and effectively relay information between the climber and belayer.

BELAY LANGUAGE

- **"On Belay"** (Climber) - The climber is tied with an anchor knot (Figure 8 Follow Though) at the end of the belay line.
- **"Belay On"** (Belayer) - The belayer has secured the belay line with a munter-mule hitch, tending the slack in the line.
- **"Climbing"** (Climber) - The climber is ready to climb or rappel.
- **"Climb On"** (Belayer) - The belayer is ready to release slack in the belay line as the climber climbs or rappels.

LOWERING

Lowering in a controlled manner using these belay techniques is simple, effective and safe. There are a wide variety of applications including lowering a climber, lowering equipment, or using as a backup.

Chapter 10

Haul Systems

Access from Bottom of Slope – Up-Haul System

In this situation, it is assumed that you must move the heavy equipment up the slope. Thus, you have suitable anchorage (truck, trees, etc) below the slope and the ability to create anchors above the area where you will be working.

The first step - climb up to the top of slope and build anchors on which you will rappel with climb and haul lines down to the bottom of slope. The haul lines will need to include a mechanical advantage system that can be carried down to the lower anchor point.

Access from Bottom of Slope – Up-Haul System

(continued)

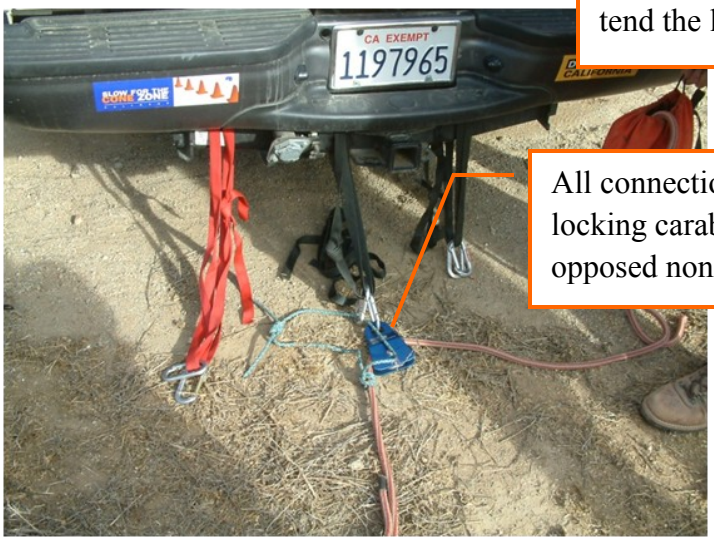
Once the climber line and haul rope have been carried to the bottom of slope, they need to be anchored to the truck or other anchor at the bottom of the slope.

This pulley is for a change of direction to allow better positioning. This situation requires a prusik backup

Access from Top of Slope – Climbers are tied in

In this situation, the access is again from the top of slope. The rigging is established to provide for one or more climbers to assist heavy equipment down the slope and then back up. This situation also requires an additional deckhand who will assist with lowering /raising the equipment and who will tend to the prusik.

Anchor setup is off the bumper of the vehicle. Make sure parking brake is set, keys are out of the ignition, and the webbing tie off avoids sharp bends and objects.



Note deck hand required to tend the line and prusik

All connections to the anchors need a locking carabiner or two opposite and opposed non-locking carabiners

Short Prusik backup (3rd hand)

Rescue 8 ring

While the climbers are rappelling with the equipment, they can use the Rescue 8 ring with short prusik (3rd hand) as the 2nd point of contact if needed to assist with a heavy load. Use conventional rappel if assistance with load is not needed.

Access from Top of Slope – Climbers are tied in

(continued)

Convert to operation to raising by installing a short prusik to the load line. Deck hand to assist with "pulling" the equipment up the slope and providing support for the heavy load when climbers are repositioning themselves.

Convert Prusik by Shortening for raising

The equipment is lifted by the climbers and supported by the deckhand. Once lifted upslope, the climbers must alternate taking turns repositioning themselves and supporting the equipment

Climbers have converted to ascending position by attaching both ascenders to rope.

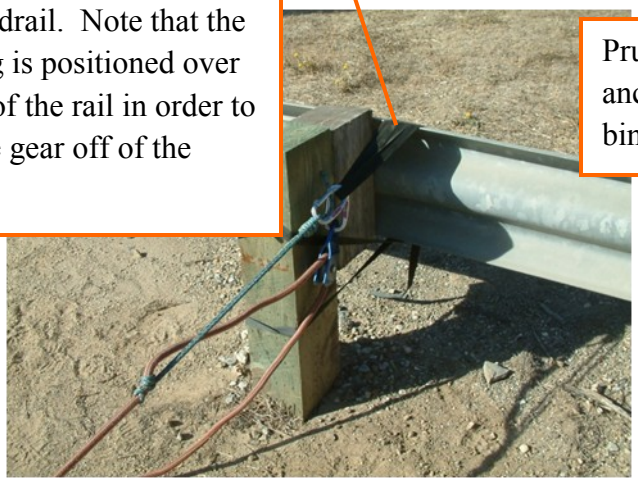
Access from Top of Slope on slope which can be walked down

In this situation, the access is from the top of slope. The rigging is established to provide support/backup for the equipment being hauled down the slope. This situation assumes that the operator can easily walk down the slope without the aid of a rope. This situation is intended to provide backup for the heavy equipment during transport and during operation.

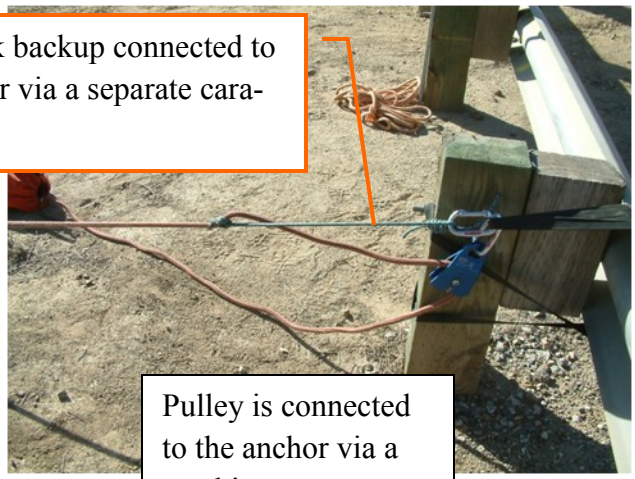
The climber is not tied in. The rigging is for the equipment being operated

The anchoring for this situation is accomplished by tying off on a guard rail element using webbing. The photo below illustrates a guard rail anchor configuration with a prusik backup. A pulley is used to limit friction in both lowering and raising. A carabiner can be used as a pulley if needed.

Webbing is used to tie off to the guardrail. Note that the webbing is positioned over the top of the rail in order to keep the gear off of the ground.



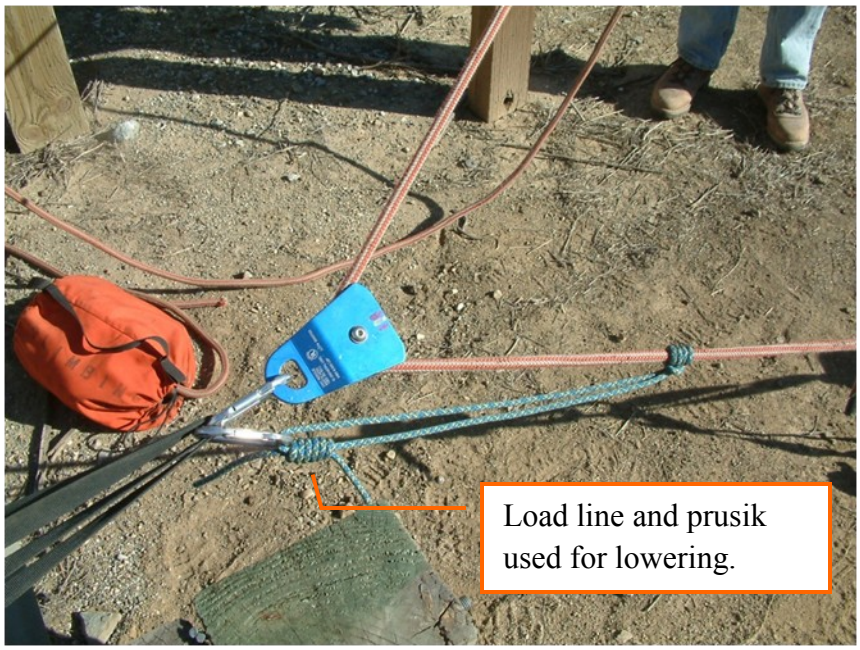
Prusik backup connected to anchor via a separate carabiner

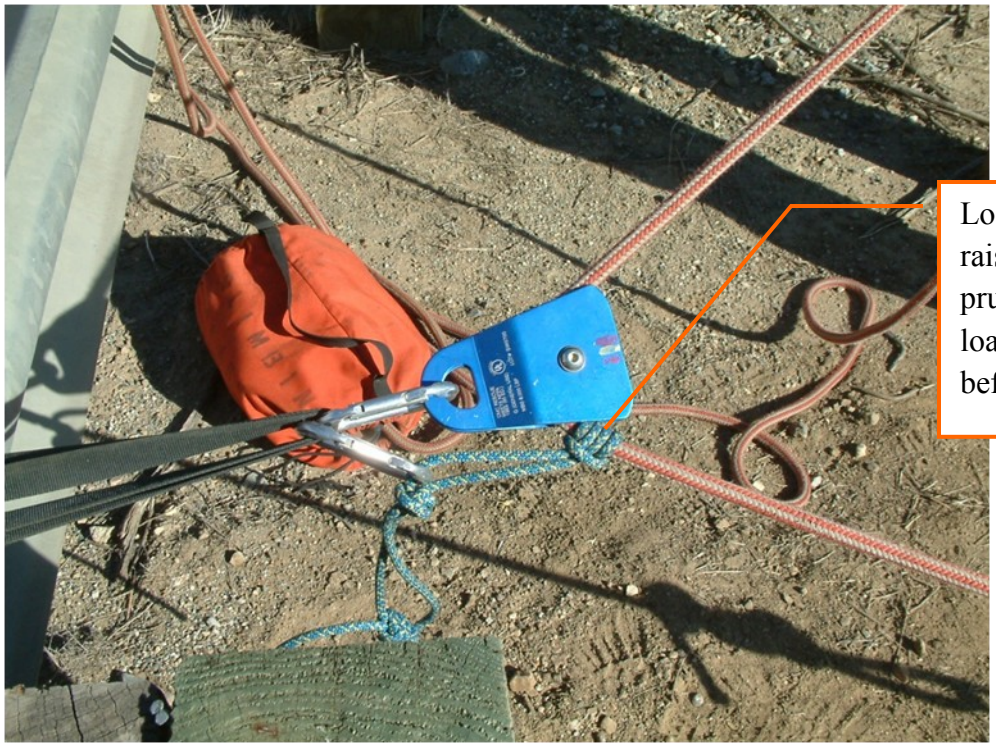


Pulley is connected to the anchor via a carabiner

Access from Top of Slope on slope which can be walked down

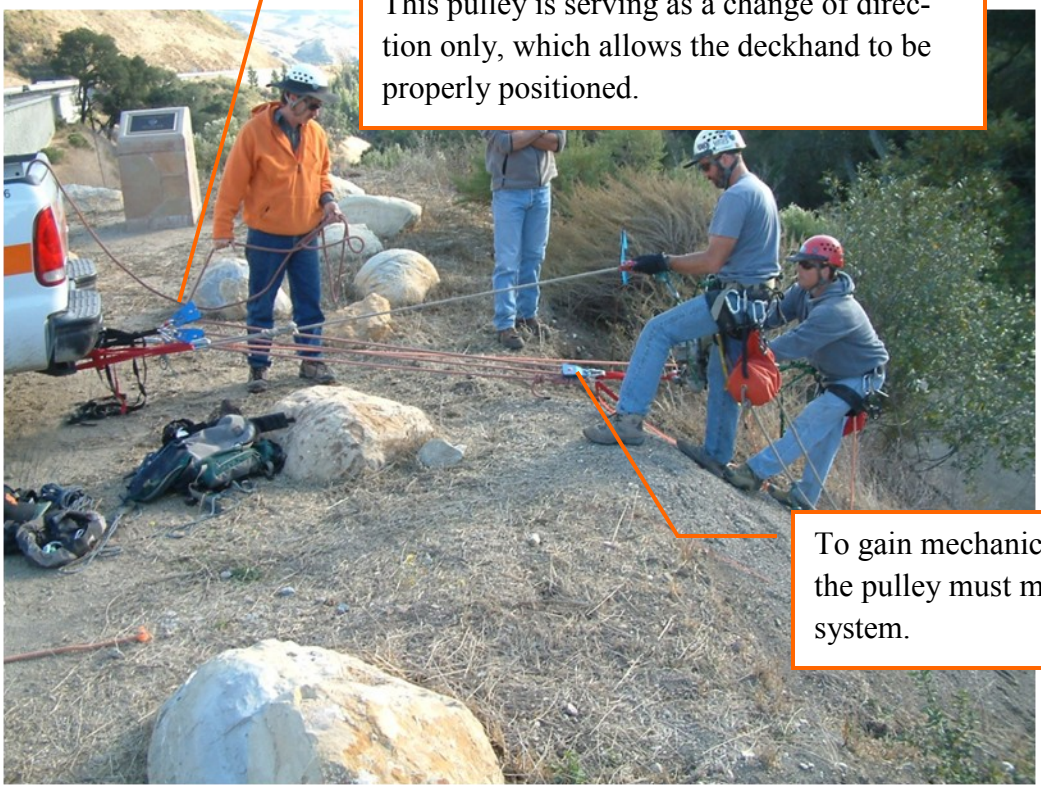
(Continued)





Mechanical Advantage Systems

Illustrated is a sample of a three to one (3:1) mechanical advantage:



Chapter 11

Aerial Rescue

Aerial Rescue

This method of aerial rescue is for use when the victim is ambulatory (able to walk). **If victim is unconscious or not ambulatory, call 911 and tell them this is a "high-angle rescue".** Ideally the rescue crew consists of a rescuer and a deck hand. The deck hand is stationed at the top of the slope to assist. The rescuer rappels down from the top of slope to the victim and transfers the victim to the rescuer's rope. The rescuer requests assistance from the deck hand to provide slack in victims rope then disconnects the victim from their rope, and rappels to the base of the slope cradling the victim during the descent. The intent is to have the victim on the rescuer's rappel rope. Rescuer uses one hand to assist the victim during the final descent to the base of the slope while using other hand to tend the 3rd hand and rappel with the Rescue 8. During rappel, the rescuer should be in communication with the victim. This allows the rescuer to offer some words of comfort and support to the victim, letting him know that a trained rescuer is on the way to help, while also getting a sense of the mental state of the victim. Another important piece of information that may be conveyed to the victim is to maintain two points of contact until the rescuer reaches him.

Step 1: Rig for Rescue/ Rappel/ Safety knot

(In the photos rescuer is secured as a right handed climber)

Extend the rescuers Rescue 8 by connecting it to the daisy chain with a locking carabiner. Ensure the Rescue 8 is within reach during rappel. Setup a double wrap rappel on the Rescue 8 to control the descent with the additional weight of the victim. Backup the rappel with a 3rd hand (cordelette and prusik hitch). Using a locking carabiner, connect the 3rd hand to a secure point on the harness. The rescuer then rappels to and stops above the victim. Rescuer then ties a safety knot (8 on a Bight) on rescuers rope with enough length to reach just below victim and attaches knot to a secure point on rescuers harness freeing up the hands of the rescuer.

NOTE: Some longer cordelettes may allow the prusik to run possibly up into the extended Rescue 8. The cordelette may need to be shortened using an overhand knot.

Aerial Rescue

(continued)

Step 2: Establish first point of contact

Using a locking carabiner, the rescuer connects the excess daisy chain from the victim's ascender to the rescuers extended Rescue 8. If victim does not have sufficient amount of excess daisy chain at ascender; rescuer will need to connect using a sling or cordelette girth hitched to the victims locking carabiner at ascender making the connection to the rescuers Rescue 8. This will become the backup point of contact for the victim.

Step 3: Chest Harness

The rescuer constructs a chest harness by connecting two slings together with a girth hitch. The open loops go over the shoulders of the victim. Girth hitch is at the back of victim. The rescuer then connects the opposing ends of the chest harness together in front of the victim with a non-locking carabiner. **This is not a point of contact.** It is a piece of equipment to help ease the victim of discomfort.

Aerial Rescue

(continued)

Step 4: Establish Second Point of Contact

Attach a locking carabiner to the victim's unused daisy chain at a length of approximately half the distance of rescuers extended Rescue 8 daisy chain. This will position the victim half way between the extended Rescue 8 and the rescuer.

The rescuer then lowers them self to a level where the locking carabiner can be attached to the rescuers extended Rescue 8. This connection becomes the primary point of contact for the victim. The victim now has two points of contact.

Aerial Rescue

(continued)

Attach the chest harness carabiner to one of the victim's daisy chains in an attempt to keep the victim in a comfortable position. **The chest harness is not a secure point of contact.**

Aerial Rescue

(continued)

Step 5: Slack and Transfer Victim to Rescuer

Ensure all points of contact are properly connected. The rescuer then calls to the deck hand for "Slack." The deck hand releases the mule knot on the victim's rope and lowers the victim with the munter hitch.

This lowering transfers the victim's weight onto the rescuer's extended Rescue 8 with 2 secure points of contact. The rescuer can now pull the victim's rope down and disconnect the victim's ascender and Rescue 8.

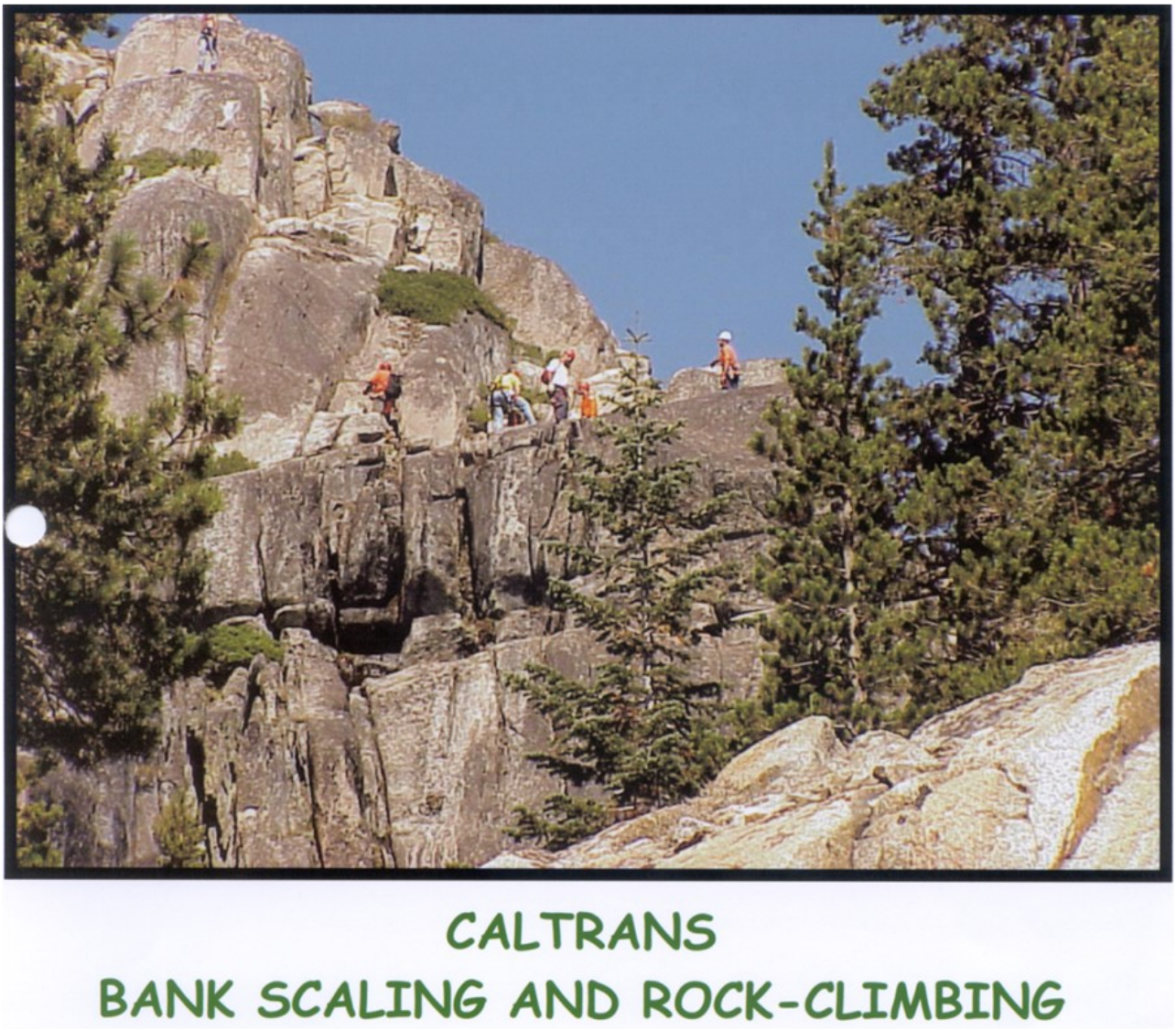
Step 6: Untie Safety Knot

Disconnect and untie the safety knot from the rescuer's rope.

Step 7: Rappel to the bottom of slope

The rescuer then rappels safely to the bottom of the slope, cradling the victim with the left hand to keep the victim in a safe position.

Terms and Definitions



Caltrans Bank Scaling and Rock Climbing Training

A

Anchor - Point where the rope is fixed.

Ascenders - Devices (e.g. Jumars) used to ascend a rope.

B

Belay, to - To secure a climber.

Belay station - A safe stance consisting of an anchor, a rope, and a belayer (AKA: "the belay")

Belayer - The person at the belay station securing the climber.

Belay “on" - When the belayer is ready to belay the climber up, he yells, "Belay on.”

Bowline - Sailing knot (not to be used for climbing, unless backed up with a second knot)

C

Cam - Generic reference to the family of spring loaded camming devices.

Carabiner - Metal connecting device. This most essential climbing device

Chock - Generic reference to the family of passive wired protection devices, also called nuts, stoppers, wires, and rocks.

Chockstone - A stone wedged between a crack, a chimney, etc.

Chute - A very steep gully. The word chute is French for fall and refers to the rockfall that is very common in a chute.

Cirque - A deep and steep-walled basin on a mountain usually forms the blunt end of a valley.

Cliff - A vertical piece of rock good for climbing (see also Crag).

Climb gear Sling - Shoulder harness designed for using and storing hardware during a big wall climb.

"Climbing" - What the climber shouts after the belayer screams "Belay on.”

Clip, to - The reassuring action of putting the rope through a carabiner.

Clove hitch - A useful, easily adjustable climbing knot .

Cord - Thin static rope (5, 5.5 or 6 mm)

Crack, in rock - A gap or fissure in the rock varying in width from nail to body width.

D

Daisy chain - A sling sewn (or tied) with numerous loops, used as an adjustable sling in aid climbing.

Descender - Device used for rappelling.

Double fisherman's knot - Solid knot used to tie two ropes or pieces of webbing together.

Double rope - Same as a half rope. Also the technique using two half ropes.

E

Edge - A sharp edge on a rock face.

Étrier - (Pronounce with a French accent). Webbing ladder used for aid climbing. Also known as an 'aider'.

F

"Falling" - Yelled when a climber is (about to) fall.

Fall factor - The length of the fall divided by the amount of rope paid out.

Figure 8 - Metal rappelling/belaying device shaped like an 8.

Figure of eight - Very popular and solid tie-in knot.

Fisherman's knot - Simple knot to tie two ropes together. The double fisherman knot, however, is more popular.

Friend - Trade name for the original camming devices, now also available as Camalots, TCU's, Quads, Aliens, Big Dudes, etc.

G

Gate - The part of the carabiner that opens.

Grade - A number that denotes the seriousness of a route: Not to be confused with the rating of climb, which describes the technical difficulty.

Gully - A wide, shallow ravine on a mountainside.

H

Harness - A piece of equipment made of various widths of nylon webbing designed to support the pelvis and legs of a climber attached to a rope or anchor.

Haul bag - Large and robust bag used to haul food, water, climbing gear, and other essential equipment that is required.

Helmet - Solid plastic device that can sometimes protect the head from falling stones or impact.

Hex - Short for Hexentrix. A type of nut with an excentric hexadiagonal shape. Works for wedging (as a nut) but also for camming.

Hold - Anything that can be held on to.

Horn - Spike of rock that can be for a great hold or not so great protection.

I

Ice axe - Device used for ice climbing, glacier crossing, or anchor building.

Ice screw - A protection device for ice climbing: Looks like a large bolt that can be screwed into hard ice.

J

Jumar - A type of rope ascending device.

Jumar, to - To ascend a rope using ascenders.

K

Kernmantle rope - Modern climbing rope consisting of bundles of continuous nylon filaments (Kern) surrounded by a braided protective sheath (Mantle).

Kilonewton - An abbreviation usually found on carabiners and other climbing gear. One kilonewton is about 100 kg or about 220 lbs.

Knotted cord - Piece of cord with a knot tied into the end that is used for protection (pretty much like a nut). The traditional method of protecting climbs.

L

Leader - The person who leads a climb.

Lead, to - To ascend a climb from the bottom up, placing protection (or clipping protection) as you go.

Ledge - Flat bit on a rock (can be miniature or gigantic).

Locking Carabiner - Carabiner that can be locked.

Lowering - To descend something or somebody.

M

Mountain rescue - Dial “911” tell them “High Angle Rescue”.

Nut - Metal wedge used for protection in cracks.

Nut tool - Piece of metal that can be used to remove stuck nuts or cams.

O

"Off Belay" - Yelled when the climber no longer requires a belay (e.g. because she/he has reached a stance). Once the belayer hears "off belay", he/she removes the rope from the belay device and yells "belay off".

"On Belay ???" - Query to verify if the belayer is ready to secure the climber.

Overhand knot - A simple (but solid) knot in a double rope.

Overhand loop - The simplest type of knot possible.

Overhang - Rock (or ice) that is "more than vertical".

P

Pendulum - A swing on the rope, either intentional to gain a distant anchor on big wall climbs or unintentional when falling during a traverse with not enough pro in place.

Pitch - A section of climb between two belays and no longer than the length of one rope (this used to mean 45m, nowadays pitches can also be 50 or even 60m long -- check your topo).

Piton - Metal spike hammered into a crack (has come in disuse for all but some special applications)

Prusik - The sliding knot or the method to ascend a rope (named after its inventor, Dr. Karl Prusik).

Q

Quickdraw, quick - Short sling with carabiners on either side.

R

Ramp - An ascending ledge

Rappel, to - Also: to rap. Descending by sliding down a rope. Known in Britain (and Germany) as abseiling.

Rappeler - Individual who is sliding down ropes.

Rating - A number denoting the technical difficulty of the climb. See here for more on ratings and grades.

Rib - A slender buttress. Something between a buttress and an outside corner.

Ridge - The high divide extending out from a peak.

Ring - A large (2 inch diameter) ring that is cemented in the rock as a bolt. Rings are very common in Germany and France and are excellent for rappelling and hanging belays.

"Rock" - Scream let out to warn people down below that a piece of rock has been overcome by gravity. The loudness, number of repetitions, and/or panic in voice with which this word is uttered is often an indication of the seriousness of the rock.

Roof - Seriously overhanging part in a climb (more or less horizontal).

Rope - Long and round nylon fabrication. Climbing ropes are generally between 10 and 11 mm in diameter (with the exception of "half ropes" which are between 8.5 and 9mm in diameter).

"Rope" - Should be yelled when a rope is about to be thrown to the base of the crag (though most of the time it seems like "rope" is shouted about 1-2 seconds after the rope is thrown).

Route - A certain path up a rock or mountain.

Runner - A loop of tape or webbing either sewn or tied. In the UK, a 'runner' is a running belay. A runner threaded or looped around chockstones, flakes, horns or chickenheads for protection.

S

Scrambling - Easy climbing, usually no rope required.

Scree - Loose rocks and stones that cover the slope below a cliff. With every step, scree slides under your feet.

Manual gate carabiner- The type of carabiner that can be locked with a dedicated action. See also twistlock. In the US this is usually called a 'locking carabiner'.

Sling - A sling (Runner) is an item of climbing equipment consisting of a tied or sewn loop of webbing.

Summit - The top of a mountain or rock.

Summit, to - To reach the summit.

T

Talus - Large blocks of rock. A coarse variation of scree.

Tape knot - Or threaded overhand knot.

"Tension!" - Yelled out to the belayer to make sure he really takes in the slack. Usually "tension" is used by a climber that is ready to pop off. The progression of severity usually goes "up rope", "tight rope", "tension!".

"That's me" - Part of the climbing dialogue. Courtesy call to the belayer to indicate that the slack in the rope is all taken up and that further pulling is pointless.

"Topo - A short drawing of the route. Good topos will allow you to spot the line right away, show the placement of bolts and belay stances, indicate where the crux is and what rating it has.

Top-rope - Free climbing a route that has the safety rope attached to the top of the climb (usually one walks to the top to set up the top-rope belay).

Traverse - Horizontal climb.

Twistlock - A locking carabiner where the gate is locked with a spring-loaded clip.

U

V

W

Water knot - See tape knot.

Webbing (loop of) - A runner made of webbing either sewn or tied.

X

Y

Z

Z-Pulley System - Complicated rope setup that allows you to hoist heavy weights with relatively little force. Excellent for rescuing or hauling bags.

Caltrans Bank Scaling and Rock Climbing Training

Appendices

Appendices A: Course Information

- CT Climbing Gear List A-2
- Strength of Materials A-3
- Beginner Class A-4
- Refresher Class A-5
- Equipment Inspection Checklist A-6

Appendices B: FORMS

- Safety Meeting Report A-7
- Slope Scaling Assessment (1) A-8
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- S31040 Rock Scaling A-16

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- A-17-18

Caltrans Bank Scaling and Rock Climbing Training

CT CLIMBING GEAR LIST

Eastside sports in Bishop, Ca. has agreed to serve as a one stop shop for our Caltrans Climbers. As such, you can call them and ask for the current Caltrans Climber package. The phone number is 760-873-7520. They are on the approved vendor list as #VC0000012031 Wilson Eastside Sports in Bishop Ca.

If you prefer to use another vendor, we have successfully used the outfits shown below to purchase the items listed. The pricing and item numbers change periodically so if you choose to order from one of these vendors, make sure you are getting what we have recommended.

The following is the current recommended gear list. You can purchase the entire package or individual items as needed. Prices are subject to change.

Yates Gear Inc.
1-530-222-4606, yatesgear.com

Item	Item#	Qty	Price	Extension
Tactical Shield Harness (military style buckle)	208	1	159.00	159.00

REI Commercial Sales
1 (800) 258-4567, REI.com

Item	Item#	Qty	Price	Extension
7 mm Accessory Cord	716226	50 ft	.45/ft	22.50
9/16" Webbing (Slings and Daisy Chains)	610111	50 ft	.28/ft	14.00
1" Webbing	737298	100 ft	.36/ft	36.00
Auto Locking Pear Shape Carabiner (large)	698146	6	18.25 ea	109.50
Non Locking Carabiner	662847	6	6.50 ea	39.00
Petzl Ecrin Roc Helmet	471157	1	99.99 ea	99.99

Bishop Company
562-698-9818

Item	Item#	Qty	Price	Extension
½" New England Rope (Safety Blue Line)	Spool (600ft)	1	359.00	359.00

CMI
1-800-247-5901, CMI-Gear.com

Item	Item#	Qty	Price	Extension
CMI Ultrascenders Large	ULT01B	1 pair	164.60	142.40
CMI Rescue 8	Rescue R1000	1	45.95	45.95

CMC Rescue
1-800-235-5741, cmcrescue.com

Item	Item#	Qty	Price	Extension
Rope Bag 100ft -orange	430101	2	31.00	62.00
Rope Bag 200ft -orange	430201	2	54.00	108.00

Eastside sports in Bishop, Ca
1(760)873-7520

Item	Item#	Qty	Price	Extension
Personnel Anchor system (sewn looped Daisy Chain)		2	50.00	100.00

TOTAL (APPROX) = $ 1297.34

STRENGTH OF MATERIALS

ROPE
1/2" (12mm) Safety blue 7,000lbf=30-31kN
7mm (cord) 2,500lbf=10-11kN

WEBBING
1" tube 4,000lbf=16-17kN
9\16" tube 2,300lbf=9-10kN

SLINGS
Cordelette (7mm) (double fisherman's bend) 1,975lbf=7-8kN
Webbing 1"tube (water knot) 2,560lbf=10-11kN; 9\16"tube (water knot) 1,472lbf=5-6kN

HARNESS\BELT
Yates "Shield" 3,600lbf=16kN

CARABINERS
OMEGA oval non-locker: spine 4,950lbf=22kN; open 1,350lbf=6kN; side 1,800lbf=8kN
OMEGA quick lock: spine 5,395lbf=24kN; open 2,020lbf=9kN; side 2,250lbf=10kN

ASCENDER
CMI "Ultrascender" 4,600lbf=19-20kN (At a 42" free fall ascender tears sheath)

RESCUE 8 RING
CMI Rescue 8 10,000lbf=43-44kN

CLOVE HITCH
Testing by the Department of Defense indicated that it was possible for the knot to slip at 700 to 1200 lbs of load and for the sheath destruction and core damage to occur at 1200 to 1400 lbs. When tied incorrectly, with the load strand farthest away from the spine of the carabiner, it was found that the knot tried to align itself with the spine at 250 lbs and carabiner failure occurred before rope breakage - at approximately 38 % of the carabiners rated strength.

CLASS CHECKLISTS

Caltrans

BANK SCALING AND ROCK CLIMBING

BEGINNER

- FIGURE-8 *stopper knot*
- 8-ON-A-BIGHT *anchor & tie off fray*
- FIGURE-8 FOLLOW-THROUGH *anchor & connect ropes*
- WATER KNOT *sling & ascenders*
- FISHERMAN'S BEND *cordelette*
- GIRTH HITCH *anchor & sling*
- BASKET HITCH *anchor*
- PRUSIK HITCH *point of contact, third hand, & double rope rappel*
- MUNTER MULE *belay & aerial rescue*
- CLOVE *carabiner& post*

ANCHORS
- FRICTION ANCHOR
- FIGURE-8 FOLLOW THROUGH

BATMAN SLOPE
- RAPPEL & ASCEND
- RAPPEL w/ THRUST RESCUE
- RAPPEL w/ SELF RESCUE
- BELAY w/ MUNTER (*climber, belayer, & deck hand)*

BUNNY SLOPE
- RAPPEL-ON-BELAY
- RAPPEL-ON-BELAY & ASCEND
- RAPPEL-ON-BELAY & SELF-RESCUE
- RAPPEL-OFF-BELAY
- PASS A KNOT
- SWITCH ROPES

SIDEWALKS
Students must ascend each sidewalk one time.

BIG WALL
- RAPPEL-ON-BELAY
- RAPPEL-OFF-BELAY
- RAPPEL-OFF-BELAY & SELF-RESCUE

OVERHANG
- RAPPEL-OFF-BELAY
- RAPPEL-OFF-BELAY & SELF-RESCUE

CHAIN: Tie a *FRICTION* or *FIGURE-8 FOLLOW-THROUGH* anchor. Each student will connect a practice rope w/ a *FIGURE-8 FOLLOW-THROUGH*. Tie an *8-ON-A-BIGHT* in the standing end. Attach the *CORDELETTE*, which includes the *DOUBLE FISHERMAN'S BEND*, w/ a *PRUSIK HITCH* to the standing end. Attach the *SLING*, which includes the *WATER KNOT*, to the cordelette w/ a *GIRTH HITCH*. Tie a *FIGURE-8 STOPPER KNOT* to the end of the last rope.

EQUIPMENT
- BELT (x 1)
- DAISY CHAINS (x 2) *follow belay loop path*
- LOCKING CARABINERS (x 4)
- NON-LOCKING CARABINERS (x 6)
- ASCENDERS (x 2)
- RESCUE-8 (x 1) *connect to belay loop, follow the belay loop path w/ a locking carabiner, & extended on a daisy chain*
- HELMET (x 1)
- SLING (x 1) & CORDELETTE (x 1) *hand out in parking lot*

TERMINOLOGY
- WORKING END: The part of the rope you hold in your hand.
- STANDING END: Rope hanging from, or on the opposite side of, the knot from the working end.
- BIGHT: When a rope is doubled back on itself with the strands parallel and close together.
- LOOP: A twisted bight where the strands cross each other.
- TAIL: The short end left over, dangling from one side of a knot near the end of the rope.
- KNOT: Two parts of the same rope purposefully twisted or intertwined.
- BEND: Two ropes or the ends of the same rope joined together.
- HITCH: Fastening a rope to a fixed object (tree, carabiner, or rope).
- FLAKE: To coil or uncoil the rope one layer at a time into a stack.

BANK SCALING AND ROCK CLIMBING

REFRESHER

DAY 1

Review BEGINNER SKILLS. Introduce the EQAUALETTE *(2-point, 3-point, Magic-X).* ROPE-RODEO

DAY 2

Set up two anchors with Munter Mules on Batman Slope. Teach the Aerial Rescue. Rotate as Victim, Rescuer, & Deck Hand at least two times.

AERIAL RESCUE

1. RESCUER SET-UP. The Rescuer connects to a climbing rope using a Third Hand and an Extended Rescue-8. Rescuer rappels to and stops above the Victim.
2. SAFETY LINE. Connect the Victim's excess daisy chain hanging from the ascender connected to the climbing rope to the Extended Rescue-8 using a locking carabiner. If the excess daisy chain is not long enough, girth hitch a sling or cordelette to the excess daisy chain or locking carabiner.
3. CHEST HARNESS. Construct a chest harness by connecting two slings together with a girth hitch. Insert one arm of the Victim into one loop, wrap the chest harness around the back of the Victim, and insert the other arm into the other loop. Connect the opposing ends of the chest harness together in front of the Victim with a carabiner.
4. SHORT DAISY CHAIN. Disconnect the Victim's unused daisy chain from the ascender. Connect the daisy chain to the chest harness as close as possible to the Victim's belt. Connect a locking carabiner to the daisy chain above the chest harness connection point. The proximity of the locking carabiner to the belt will dictate the distance between the Victim and Rescuer when descending. Holding this locking carabiner open, the Rescuer will rappel until they can connect it to the Rescuer's Rescue-8 or the Safety Line locking carabiner. *REMAIN SEPARATED. Do not connect the short daisy chain to the Rescuer's daisy chain or locking carabiner.*
5. SLACK & REMOVE. Ensure all points are properly connected. The Rescuer call for, "SLACK." The Deck Hand partially unties the Mule and informs the Rescuer that they will, "FEEL A POP". The Deck Hand unties the remainder of the Mule. The Victim's weight is transferred to the Rescuer's climbing rope. While the Deck Hand controls the Munter, the Rescuer pulls the Victim's rope toward them and disconnects the Victim's Rescue-8 and ascender from the slacked climbing rope.
6. RAPPEL. Cradling the Victim, the Rescuer will rappel until the Victim can be laid softly onto the ground.

Each group rotates as Victim, Rescuer, & Deck Hand at least one time at the Big Wall and one time at the Overhang.

BANK SCALING AND ROCK CLIMBING

EQUIPMENT CHECK

HARNESS (x 1) • Appropriate type (big Wall no Rec. climbing harness), size, and fit (two finger rule). • Ensure waist and leg loops are buckled and snug with no twists. • Inspect condition of, material, stitching, buckles, gear loops, and belay loop (tug test).	HELMET (x 1) • Appropriate type, use climbing helmets only, no hard hats. • Ensure proper fit, chin strap is buckled and snug with no twists. • Ensure a name tag is on front of helmet.
DAISY CHAINS (x 2) PERSONAL ANCHORING SYSTEMS • Appropriate type (use tied webbing or individual stitched loops). • Attached with a girth hitch that follows the belay loop path.	LOCKING CARABINERS (x 4) & NON-LOCKING CARABINERS (x 6) • Inspect each carabiner for damage and proper function. • Inspect for cracks, large nicks, sticking gates, and/or seized action locks.
ASCENDERS (x 2)  • Appropriate type (preferred CMI Ultrascenders). • 2 webbing loops (redundancy) with water knots (never too much tail). • Loops attached to locking carabiners connected to daisy chains. • Inspect condition of teeth and moving parts (cleanliness and no sticking) • Adjust the lengths of the daisy chains.	RESCUE-8 (x 1) DESCENDER OR BELAY PLATE  • Appropriate type with ears and sufficient number of holes to accommodate connecting carabineers (preferred CMI Rescue 8 Ring). • Inspect condition (cracks, excessive wear and rope burns). • Connect to either the belay loop, to a locking carabiner that follow the belay loop path, or extended on a daisy chain (always use locking carabiner). • Tap for soundness (ping not thud).
SLING (x 1) & CORDELETTE (x 1) • Inspect condition of webbing and chord (cleanliness, frays, and cuts) • Sling tied with water knot (never too much tail) • Cordelette tied with fishermen's bends.	ROPE • Inspect condition of rope during flaking. • Cleanliness, frays, and cuts. • Abraded or stretched sheath. • Hard or soft core. • Discoloration (chemical or UV light exposure)
CARE & STORAGE • Avoid exposure to UV light, excessive/unnecessary abrasion, & chemicals (solvents). • Wash soft equipment (rope, harness, daisy chains, sling, and cordelette) in washing machine or by hand and line dry in shade. • Discourage loaning gear (knowledge of equipment history and to maintain possession)	Personal Protective Equipment (PPE) • Leather gloves (no synthetic materials). • Safety Glasses • Boots/Long Pants/ • Shin Guards (Optional)

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

SAFETY MEETING REPORT

PM-S-0110 (REV. 05/2009)

Lock Data on Form

ACTION AND DISTRIBUTION:

- ☐ 1. First-line supervisor conducts meeting, completes, and sign form.
- ☐ 2. First-line supervisor retains and posts one copy.
- ☐ 3. First-line supervisor sends original to second-line supervisor for review.
- ☐ 4. Second-line supervisor reviews, signs original, and returns to first-line supervisor to file.
- ☐ 5. Additional routing to:

Note: See Chapter 2, Safety Meetings, in the Caltrans Safety Manual for details.

DATE	OFFICE / CREW / PROJECT NAME	COST CENTER / PROJECT NUMBER

PRINT NAME OF EMPLOYEES (Add additional sheets if required)

SAFETY TOPICS DISCUSSED

SAFETY SUGGESTIONS/COMMENTS

SUPERVISOR'S COMMENTS

FIRST-LINE SUPERVISOR SIGNATURE	DATE	SECOND-LINE SUPERVISOR SIGNATURE	DATE

SUGGESTED TOPICS FOR DISCUSSION

☐ Safe work habits	☐ Maintenance, Chapter 8	☐ Respirator safety	☐ Safety vest
☐ Safe work conditions	☐ Traffic control/flagging	☐ Confined spaces	☐ Body protection
☐ Codes of Safe Operating/Work Practice	☐ Slip/trip/fall hazards	☐ Hard hats	☐ Foot protection
☐ First aid treatment	☐ Protective vehicles	☐ Safety glasses	

ADA Notice For individuals with sensory disabilities, this document is available in alternate formats. For information call (916) 654-6410 or TDD (916) 654-3880 or write Records and Forms Management, 1120 N Street, MS-89, Sacramento, CA 95814.

Caltrans Bank Scaling and Rock Climbing Training

Slope Scaling Assessment **Version 4.1**

Dist. _____Co. _____ Rte._____PM _____ Dir:____ ADT:_____
Slope Name: _____ Classification of Slope: _____
Preparer:_____ Reviewed By: _____ Date:_____(valid for 90 days max)

This form is to be prepared by a trained, qualified person and sent to Geotechnical Services for review by qualified personnel.

Previously Classified: no yes if yes, **Date:_____ Prev. Classification : _____**

PART 1 : GENERAL SITE INFORMATION

Slope Description

Cut Slope Natural Slope Recent/Old Slide (requires 2nd level review, contact Geotechnical unit in your area for additional review)

Slope Length (sketch in cross section in Part 2)

<100' <200' <400' >400' (significant exposure time)

Slope Angle (sketch in cross section in Part 2)

35° to 45° >45° to 70° >70° to 90° Overhanging

Slope Width (sketch in front view) W =_____(W/20 = # of Scalers) # of Scalers_____

Catchment Ditch Effectiveness (sketch in cross section in Part 2)

Good Catchment Moderate Catchment Limited Catchment No Catchment

Anchor Conditions above Slope (sketch in cross section)

Access	Easy	Difficult			
Angle	Flat	Moderate	Steep		
Vegetation	Trees	Shrubs	None		
Rock Outcrops	No	Yes	If yes, Many	Few	
Other Anchors (Ex. Fences, Utility Poles, Heavy Equip.)			No	Yes	Type_____
Mechanical Anchors Needed (Ex. Pickets, Fall-tech, Heavy Equip.)			No	Yes	Type _____

Exit Conditions

Dirt Road/Trail	**yes**	**no**	_____
Cross Country	**yes**	**no**	_____
Ropes required	**yes**	**no**	_____

Presence of Water (sketch in cross section and/or front view in Part 2) No Yes

If yes, Dry Wet Flowing

Chutes (sketch in front view) No Yes

If yes, Spacing: <20' 20' to 50' >50'

Shape/depth U shaped gentle sides U shaped steep sides V shaped steep sides

Overhangs (sketch in cross section and/or front view in Part 2) No Yes

If yes, <5' >5'

Slope Materials (sketch in cross section)

Soil Soil and Rock Rock

Rockfall Size S (<1' dia) M (1'–3' dia) L (3'-6' dia) XL (>6' dia)

Average _____ Maximum _____

Key Blocks (sketch in cross section and/or front view in Part 2) No Yes

Previously Scaled No Yes Don't Know

Slope Scaling Assessment **Version 4.1**

Dist. _____Co. _____ Rte._____PM _____ Dir:____ ADT:_____
Slope Name: _____ Classification of Slope: _____
Preparer:_____ Reviewed By: _____ Date:_____(valid for 90 days max)

PART 2 : SLOPE DIAGRAMS

Cross Section Sketch (use range finder)	**Front View Sketch**

Legend

CL = Highway Centerline

☺ = Location of Photo

↡ = Chute

↯ = Water

↴ = Overhang

Comments : _____

Caltrans Bank Scaling and Rock Climbing Training

Slope Scaling Assessment **Version 4.1**

Dist. _____ Co. _____ Rte._____ PM _____ Dir:_____ ADT:_____

Slope Name: _____ Classification of Slope: _____

Preparer:_____ Reviewed By: _____ Date:_____ (valid for 90 days max)

PART 3 : CLASSIFICATION SCORING SUMMARY				**Notes**
Old/New Slide	Pending Review	**Class 5**	○	_____
Slope Length	< 100 feet	Class 1	○	_____
	< 200 feet	Class 2	○	_____
	200 feet to 400 feet	Class 3	○	_____
	> 400 feet	Class 4	○	_____
Slope Angle	35° to 45°	Class 1	○	_____
	45° to 70	Class 2	○	_____
	> 70°	Class 3	○	_____
Anchor Conditions above the Slope				
Angle	Flat 0 to 20°	Class 1	○	_____
	Moderate 20° to 45°	Class 2	○	_____
	Steep >45° to 70°	Class 3	○	_____
	Vertical > 70°	Class 4	○	_____
Anchor Types	Trees	Class 1	○	_____
	Rock Outcrops	Class 2	○	_____
	Other	Class 3	○	_____
	Shrubs	Class 3	○	_____
	Mechanical	**Class 5**	○	_____
Slope Face Conditions				
Presence of Water	Dry	Class 1 and 2	○	_____
	Wet	Class 3 and 4	○	_____
	Flowing	**Class 5**	○	_____
Chutes Spacing	No chutes	Class 1	○	_____
	>50’	Class 2	○	_____
	20’ to 50’	Class 3 and 4	○	_____
	<20’	**Class 5**	○	_____
Overhangs	<5’	Class 1 to 4	○	_____
	>5’	**Class 5**	○	_____
Rock Size	S-M	Class 1 and 2	○	_____
	L	Class 3 and 4	○	_____
	XL	**Class 5**	○	_____
Key Blocks	No	Class 1 to 4	○	_____
	Yes	**Class 5**	○	_____

Overall Classification : _____

(Class 5 requires 2nd level review. Contact Geotechnical unit in your area for additional review)

Slope Scaling Assessment **Version 4.1**

Dist. _____Co. _____ Rte._____PM _____ Dir:____ ADT:_____
Slope Name: _____ Classification of Slope: _____
Preparer:_____ Reviewed By: _____ Date:_____(valid for 90 days max)

PART 4 : PHOTO PAGE

Scaling Crew		
Hand Scalers	**Look outs**	**Competent person on site watching slope**
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

CT Climbing Harness Inspection Form

Inspector (Primary User): _____ Date: _____

Inspector (Co-worker/Supervisor): _____

Harness Manufacturer, Model & Serial Number: _____

Harness Checklist:

Examine each component for signs of damage. In non-metal stitched components, look for fraying, splits, stains, weathering, lack of suppleness, and other signs of wear. In metal and plastic components, look for cracks, grooving, warping, and other signs of wear.

Items to be checked:	Yes (OK)	No (Give descriptions)
Belay Loop		
Harness Belt		
Leg and Crotch Loops		
Primary Attachment Points		
Buckles		
Leg Loop Connectors		
Tool Attachment Points		
Label Markings		

Comments:

_____

_____

_____

_____

User Checklist:

Has user received training on proper use of harness? _____

Date of last training: _____

Does harness fit properly? _____

Signature: _____

Caltrans Bank Scaling and Rock Climbing Training

		S NUMBER :
YEAR :	**PERSONAL CLIMBING LOG**	**NAME :**

					* Slope	Climbing Hours			
Date	**County -**	**Rte -**	**PM**	**Location Name**	Classification	**Scaling**	**Training**	**Other**	**Work Description**

	Scaling	Training	Other
Year Totals			

Total Climbing Hours

* Slope Classification for scaling locations only. Include a copy of the Slope Scaling Assessment form for each scaling operation.

S NUMBER : _____

NAME : _____

CLIMBING LOG

SUMMARY SHEET

Year	Total Climbing Hours	Scaling Hours	Training Hours	Other Climbing Hours
2003				
2004				
2005				
2006				
2007				
2008				
2009				
2010				
2011				
2012				
2013				
TOTALS				

S FAMILY ACTIVITIES

ACTIVITY	DESCRIPTION	PRODUCTION UNIT		ASSET
S10000	SAND/ROCK PATROL	VEMI	Vehicle Miles	RW
S20000	STORM PATROL	VEMI	Vehicle Miles	RW
S21000	FLOOD CONTROL	EAOC	Each Occurrence	RW
S30110	MINOR SLIDE/SLIP REMOVE/REPAIR	EAOC	Each Occurrence	RW
S31010	REPAIR/REPLACE ROCK FALL PROTECTION	EAOC	Each Occurrence	RW
S31040	ROCK SCALING	ACRE	Acre	RW
S32050	BENCH CLEANING	EAOC	Each Occurrence	RW
S33000	BLASTING	EAOC	Each Occurrence	RW
S40010	MAJOR SLIDE/SLIP REMOVE/REPAIR	CUYD	Cubic Yard	RW

TASK ACTIVITIES

TASK*	TASK DESCRIPTION
INSPCT	INSPECTION ACTIVITY
INVCPL	INVESTIGATE COMPLAINT!
OJT	ON THE JOB TRAINING
USAWRK	UNDERGROUND SERVICE ALERT WORK
SUPR	SUPERVISION

***Note:** A Task Code for charging Inspections, Complaint Investigations, On the Job Training, Underground Service Alert Work, Supervision, etc can be entered using the "Task" field on the Work Order Labor Cost Tab. (Task Definition instructions can be found in Appendix 2 of this manual.)

A Work Order should be associated with a "job", and the post mile limits should be reflective of the actual work area. This can be very important for budgetary, environmental, and legal issues.

One Work Order should not be used to record multiple work locations with a broad (all-inclusive) post mile range. Each work location should be given its own Work Order number.

Questions regarding this should be directed to your District IMMS Coordinator.

S31040 – ROCK SCALING

Purpose

Removal of loose and potentially unstable rocks and boulders from slopes if the slope has been recently damaged by storms or other catastrophic events.

Traffic control should be charged to support on the Additional tab of the Work Order when charging to this Activity, and should not be considered "M" Family work.

Special Requirements:
Note: Refer to Appendix 1 for a complete listing and description of available Maintenance Types and Priority codes.

Do not use this Activity when working for others.
Refer to Y Family, work for others.

Maintenance Type:
Supervisor Discretion

Priority Code:
Supervisor Discretion

E-FIS Project: 0000000304
E-FIS Sub Object: 036
E-FIS Reporting Code: N/A

Production Unit: ACRE
Production Unit Calculation: Acre (Measured parallel to slope).
One acre equals 43,560 square foot.

BIBLIOGRAPHY

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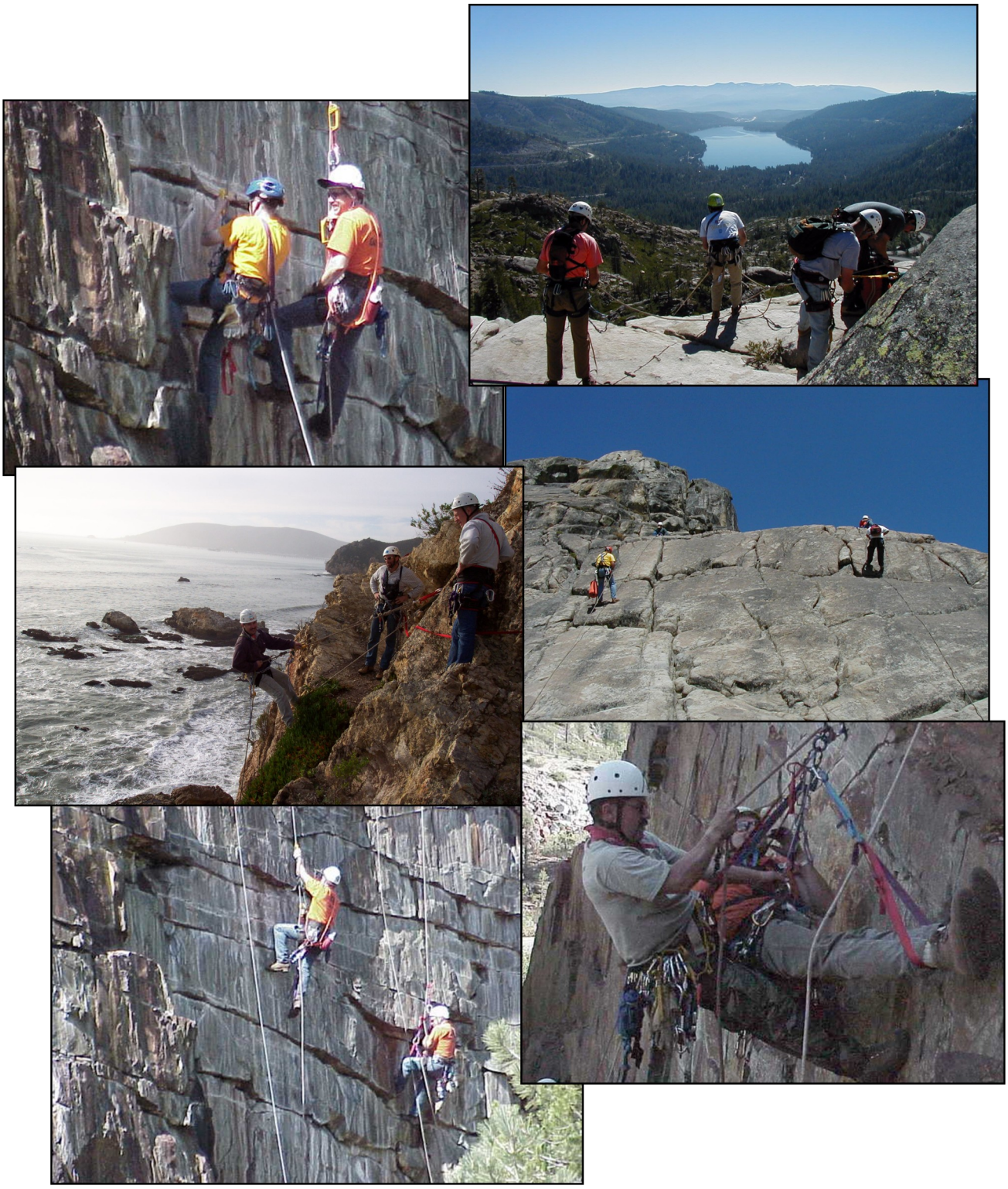
Caltrans Bank Scaling and Rock Climbing Course



Caltrans Bank Scaling and Rock Climbing Training

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